

Let's Discover Science

Book Five



David Horsburgh

Introduction

The purpose of the *Let's Discover Science* books is to give the children sufficient basic skills to learn for themselves what they want to learn. The child should, as far as possible, be given those ideas which form the basis of scientific thought. Competition and grading can well be dispensed with in a course of this nature: the children should be encouraged to co-operate with each other in experimenting and in enjoying the beauties of scientific discovery and learning from their peers should be a normal part of everyday classroom activity.

Before the child can be led to any important concepts of science, it is important to *break down* certain concepts which already, perhaps, are making their way into his mind through other aspects of his education.

The first is the idea that the textbook is some kind of divine writ, to be accepted without question, swallowed without digestion, and regurgitated in the examination.

The next: that to every question there is one correct answer and only one correct answer, and that this correct answer must always be given in the words of the book.

The next: that every effect is due to only one cause and not, as so often happens, to a multiplicity of causes.

How can the teacher break down some of these fallacious concepts? By encouraging the child to ask questions, to conduct experiments *for himself*, and to make guesses. By giving children plenty of practice at suspending their judgment and being prepared to wait and observe rather than to jump to quick conclusions; and even by the teacher and pupils occasionally saying together, "We don't know"; followed by, 'Let's find out'.

The five books in the series are designed to give children a number of skills and concepts. While the text deals, of course, with scientific matters, the emphasis must always be on learning the skills and concepts and not on learning the information contained in the text.

Observing, recording, the analysis of such recordings, and the practical applications of such analyses, are all introduced from the earliest stages. In addition a number of practical skills have been taught: learning to draw, to copy and to trace; learning to use language accurately, learning to guess with reasonable accuracy; learning to work from printed instructions.

The pages of the book should form only the beginning of the child's quest for scientific knowledge. Children should be encouraged to apply the skills and concepts they acquire from the book to every aspect of their environment and life.

A few notes for the teacher with regard to certain pages of the text have been printed at the back of the book.

David Horsburgh

Notes for the Teacher

(Notes are only given for those pages where some difficulty may be found, either in the interpretation of the page or in the work preceding or following the work of the text.)

Pages 1-7: These pages contain pictures which are designed to remind the children of some of the work and experiments which have been covered in the first four books of the series. If the children have not in fact used Books 1-4, it would be useful if you could have at least one copy of each of these books in the classroom, so that you can find out what experiments the pictures refer to. One possible way of revising is to ask children to tell you what they see in any particular picture, and then to describe the work which it illustrates.

Page 8: All these words have been used in Books 1-4 and it should be possible for children to test themselves in the way suggested on the page before you ask them questions about individual words.

Page 9: If you have a large coloured picture of the brain show it to the children. If there are facilities in your school for dissection, you can show the children the brain of a small vertebrate.

Page 10: Get the children to carry out the experiment at the bottom of the page.

Page 11: Ideal material for exhibition.

Page 14: Sometimes museums have collections of butterflies. If children can observe butterflies in the playground or the parks this is probably better than catching butterflies and spearing them with a pin, which seems to be the recognized museum practice.

Page 15: The children have learnt enlarging techniques in previous books and of course the visual squares need not be 1 inch; make them 2 inches if the children wish to make larger butterflies.

Pages 16-17: Best done in groups.

Page 19: It would be a good idea to discuss some of the ideas shown in the drawings. Find out whether the children think the ideas are practical. Get them to make drawings of their own, if possible incorporating new ideas.

Pages 20-21: Another exhibition could be arranged, but it is also important for children to carry out some extended observation of some of these small creatures over a period of time.

Pages 24-25: The notion of molecules and elements is quite a difficult one for the children to grasp and as it is a concept which will occupy an important part in their later work in science not much time need be spent on it now.

Pages 28-29: If you have anyone in your school who is qualified in giving first aid or if there is a local doctor it will be good to get him to give the children a talk.

Page 30: Let the children make a number of designs on the lines of the one shown.

Page 31: Very important that the children should carry out these experiments in groups and find out answers to the questions.

Pages 34-35: Scientific concepts, and change, will form important parts of the children's later scientific work. These two pages are an introduction only.

Page 42: Perhaps the science laboratory of your school will provide lenses for you to show the children.

Page 45: A chance for class discussion.

Page 46: Get the children to make calipers, and measure various things with them. Write down their answers.

Pages 50-51; Another introduction to some important concepts.

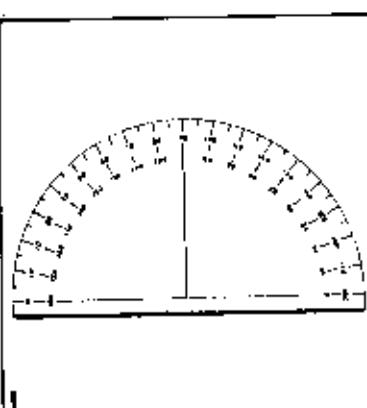
Pages 56-57: Another chance for extended observation and recording on the part of the children. From the analysis of such recordings children could predict various things. It is best to point out to the children at this stage that the only predictions that human beings seem to make about the future with certainty of success are astronomical predictions.

Page 61: The film strip projector can be used to encourage children to put down some of the results on their researches in a logical sequence and indicate them visually to the members of the class.

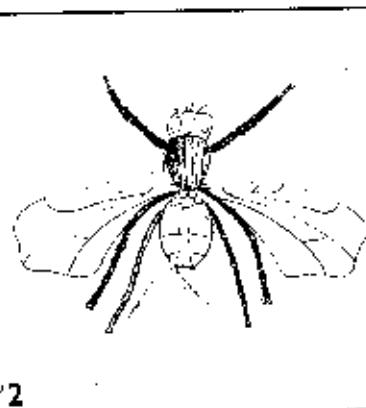
Page 65: Many beautiful decorations for the classroom can be made using these regular solids. Even if quite thin paper is used the resulting solid is remarkably strong. The faces can be painted in various colours. They can be hung up. Very beautiful decorations can be made by sticking a tetrahedron on each face of the icosahedron.

Pages 70-71: Some more ideas which will be important in later scientific work.

Page 79: Many small towns in India have small workshops where plating is carried out, and the children should be encouraged to see this process going on.



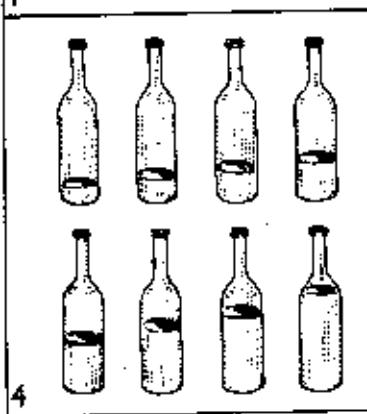
1



2



3



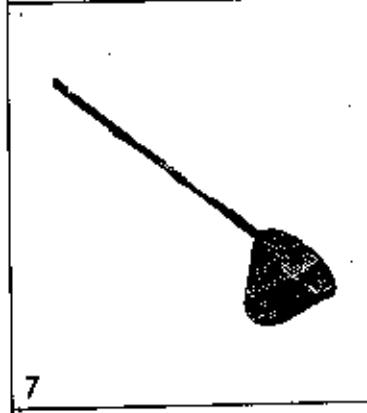
4



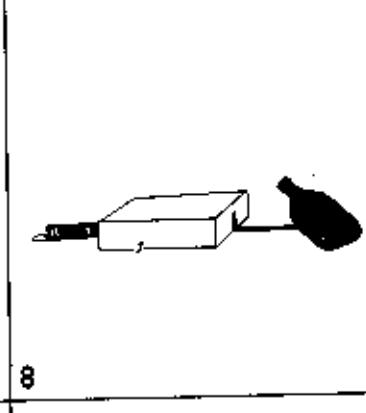
5



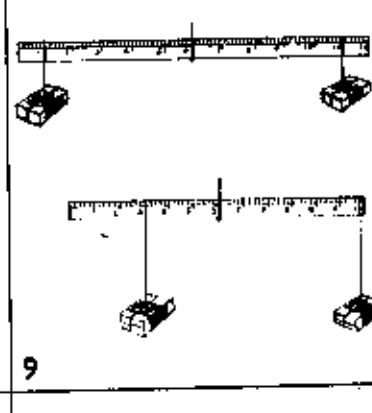
6



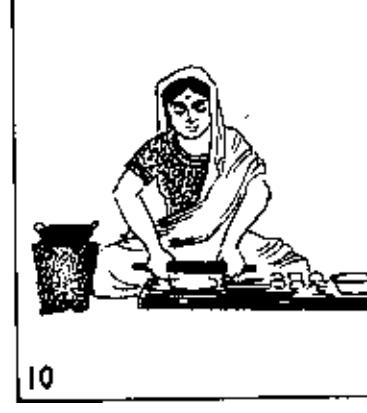
7



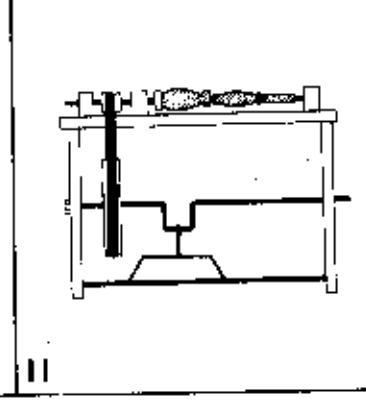
8



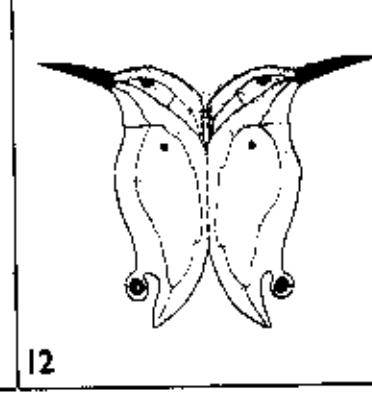
9



10



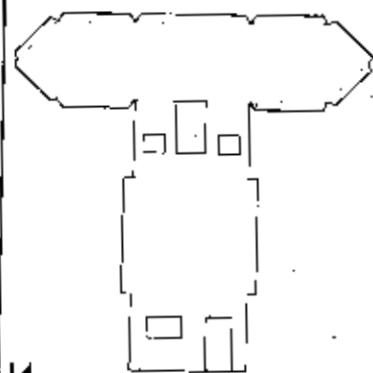
11



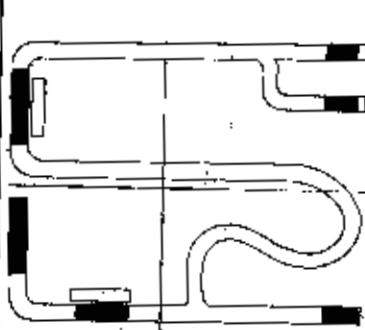
12



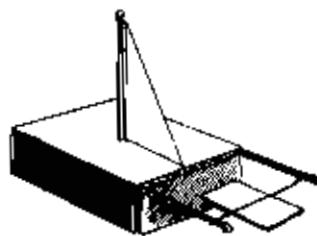
13



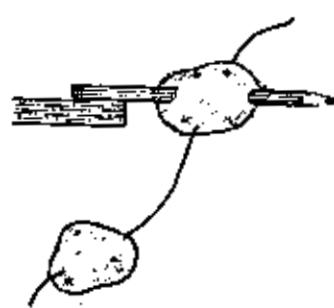
14



15



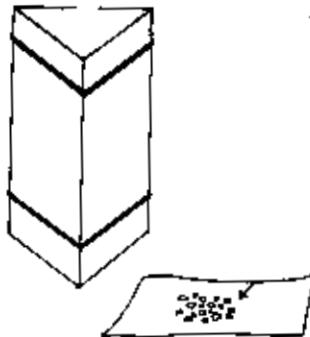
16



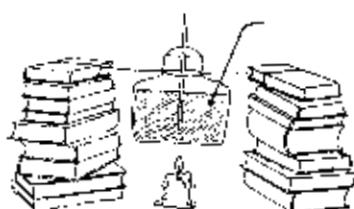
17



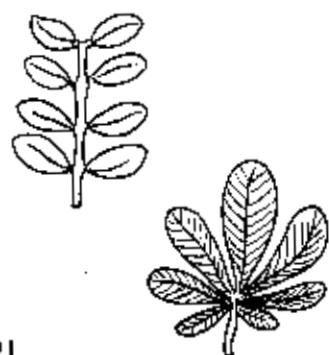
18



19



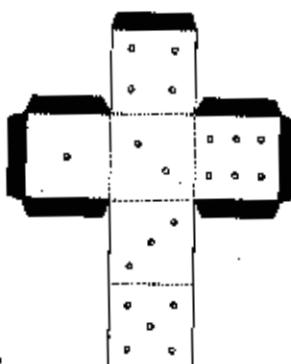
20



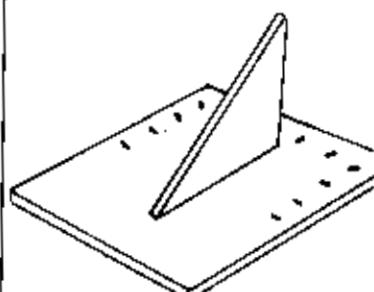
21



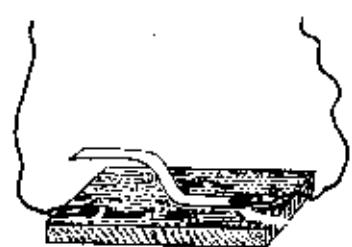
22



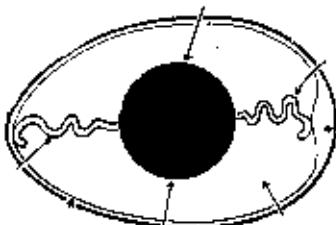
23



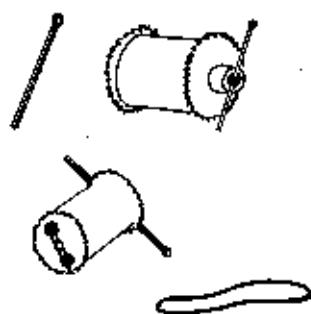
24



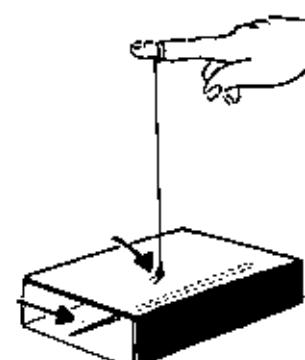
25



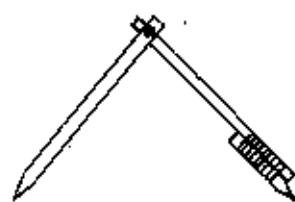
26



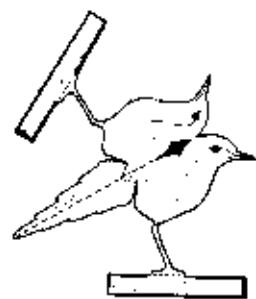
27



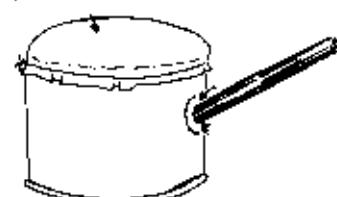
28



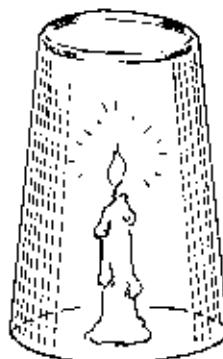
29



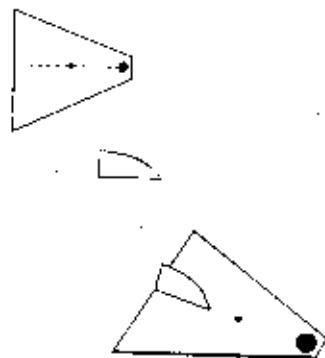
30



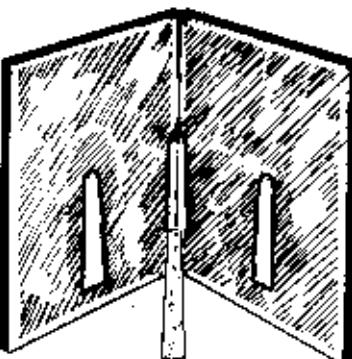
31



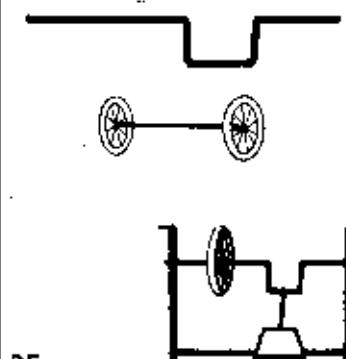
32



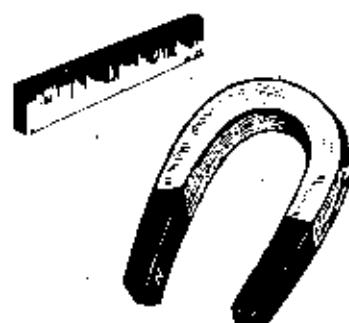
33



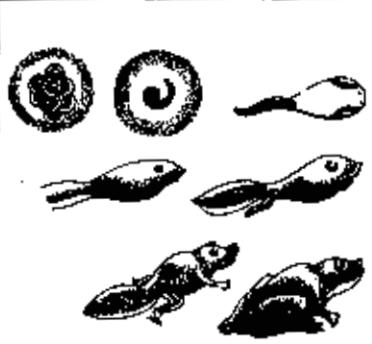
34



35



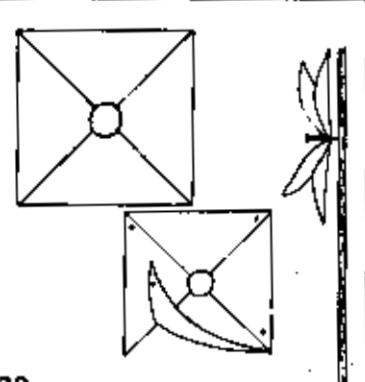
36



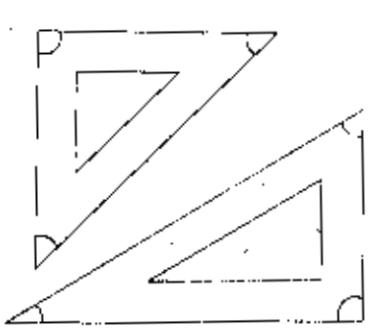
37



38



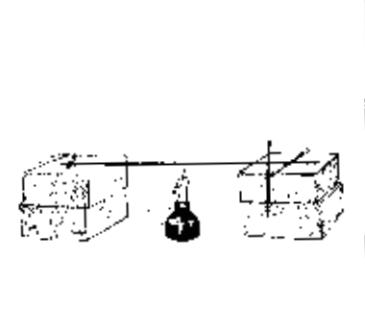
39



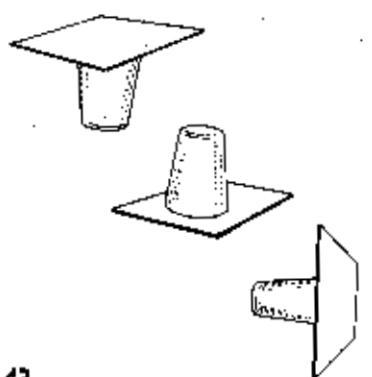
40



41



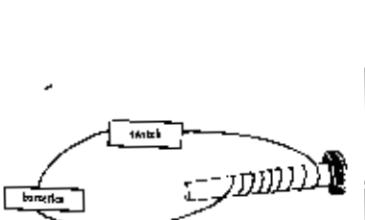
42



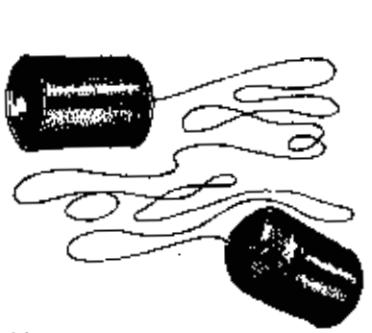
43



44



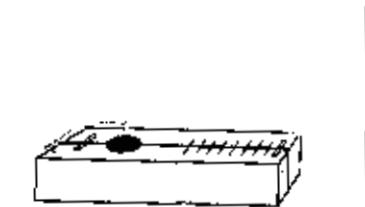
45



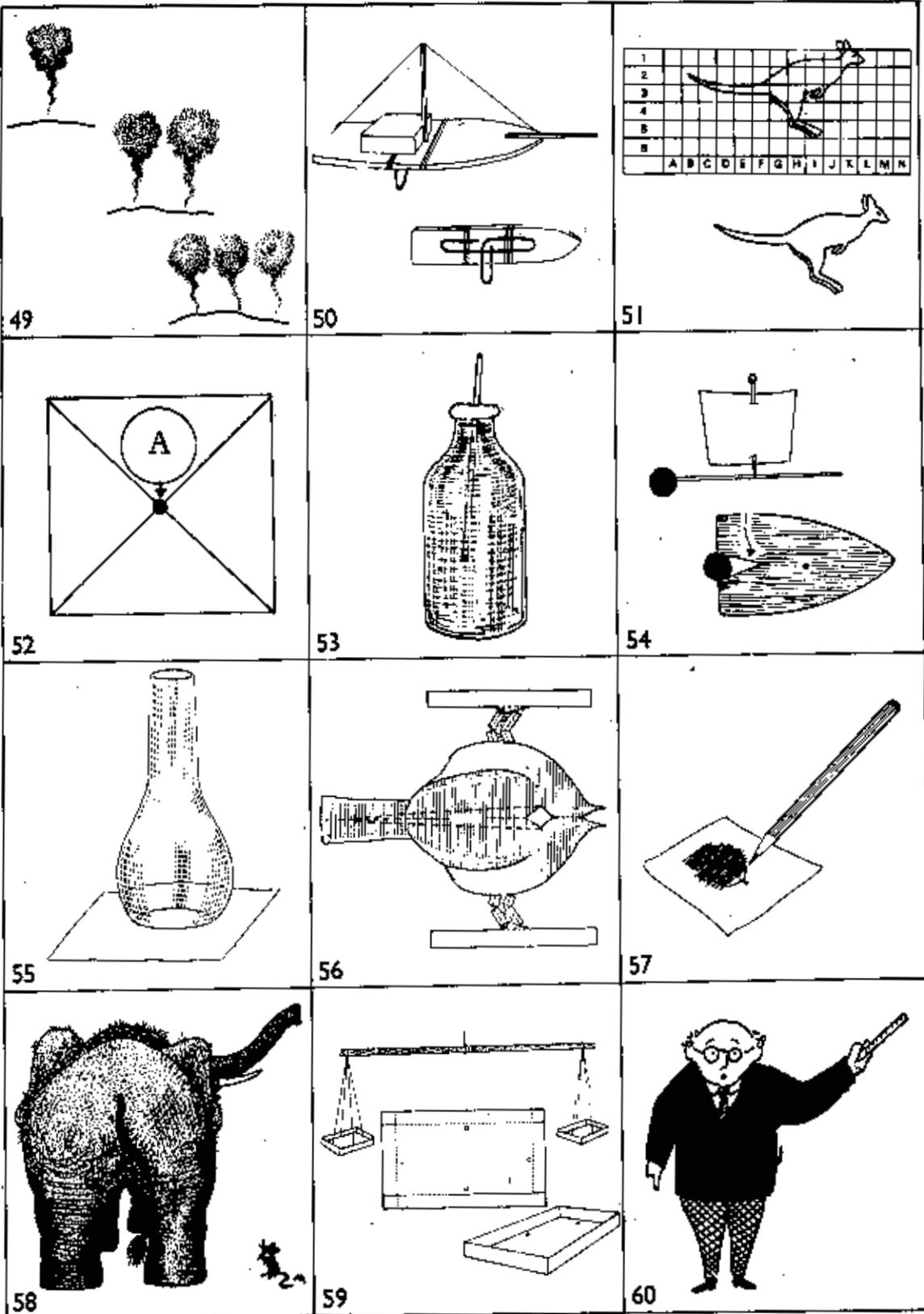
46



47

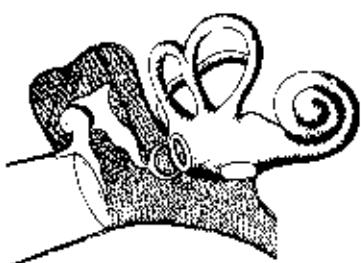


48

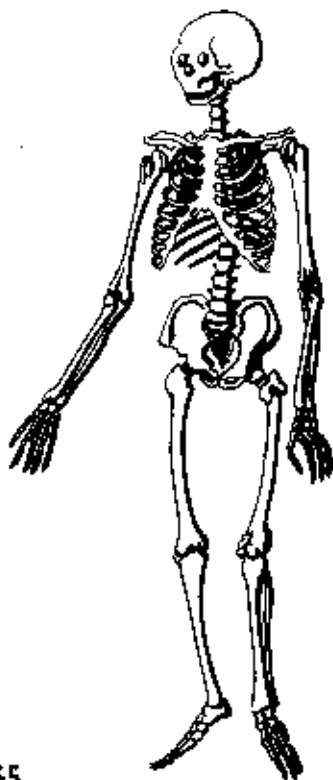




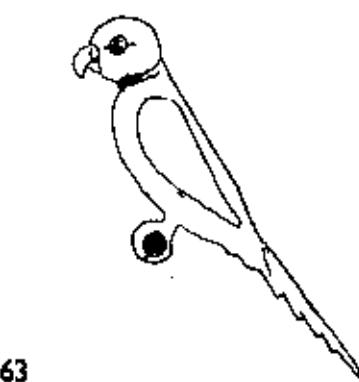
61



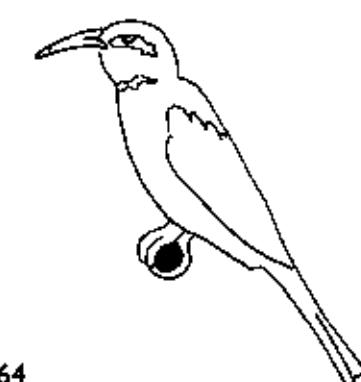
62



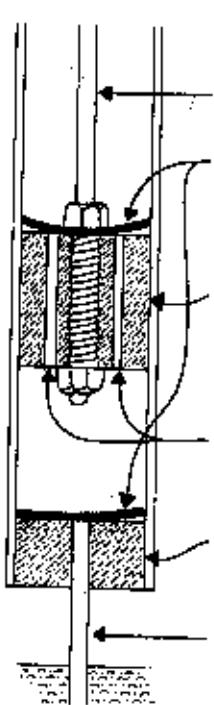
65



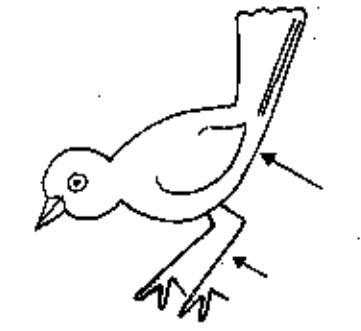
63



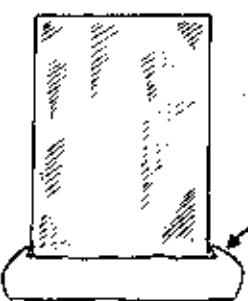
64



66



67



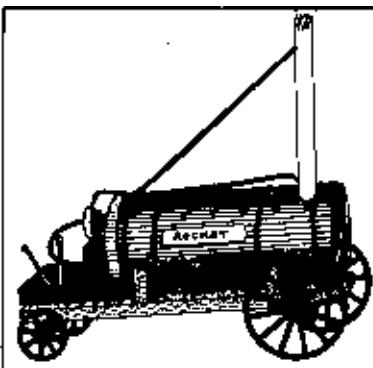
68



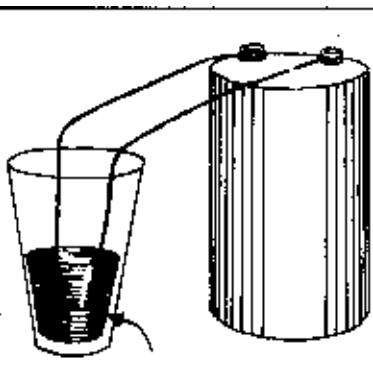
69



70



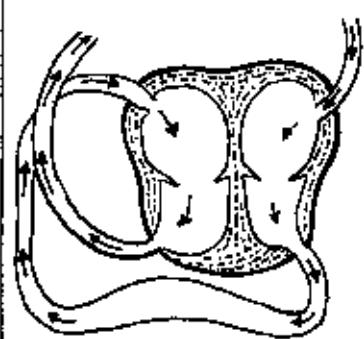
71



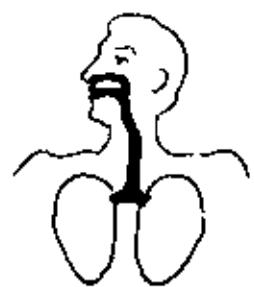
72



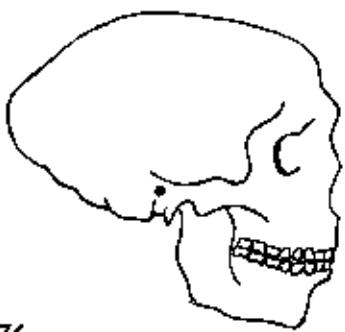
73



74



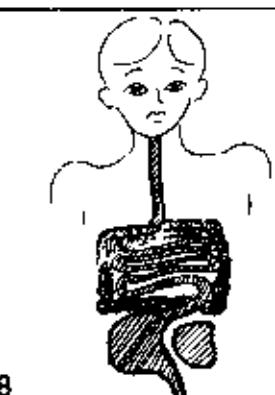
75



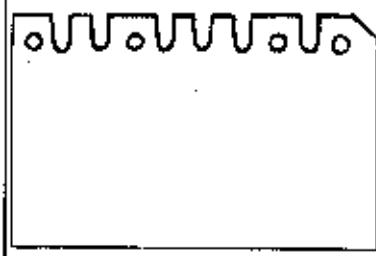
76



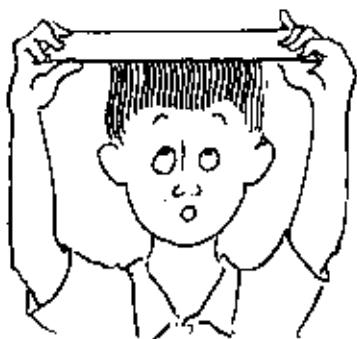
77



78



79



80



81

Revision

All the words in the lists below have been used in Books 1-4, and you should know them. The best way of finding out whether you know them is to ask yourself:

A. Can I *explain* the word? e.g.

Expand means *to get bigger*, and

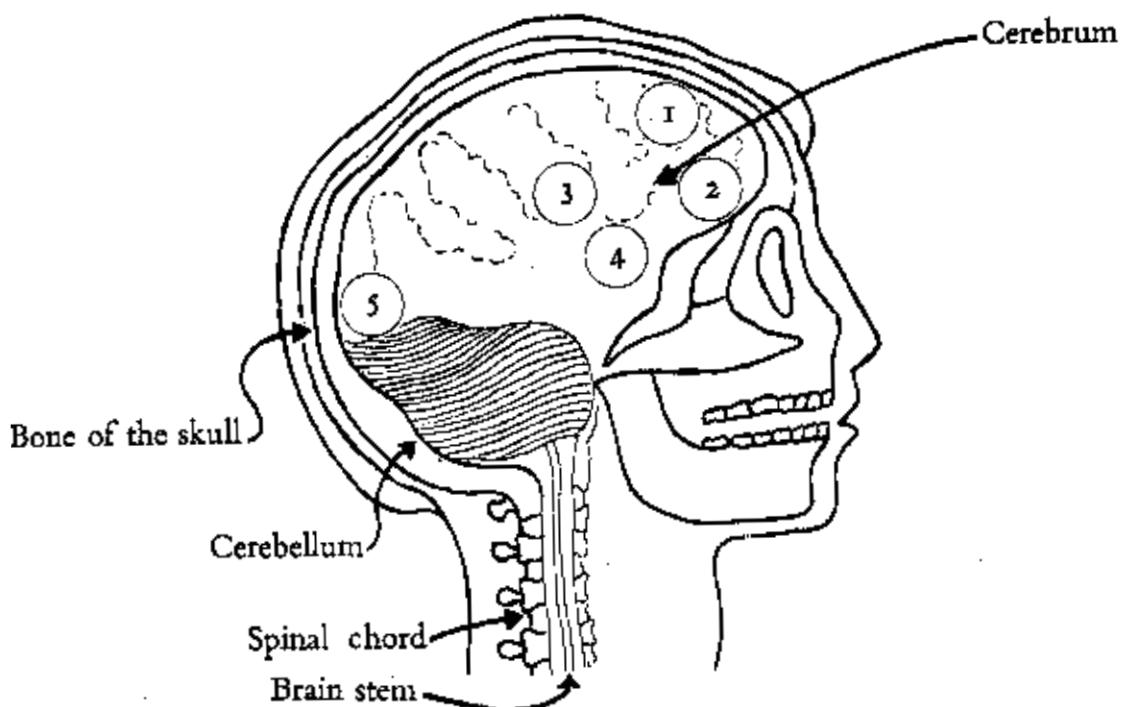
B. Can I *use* the word in a sentence? e.g.

Metal *expands* when it is heated.

Here are the words. You will need to know them when you read this book.

lever	hypothesis	treadle	pump
fulcrum	matter	flywheel	vertebrae
vocal chords	positive	sepal	heliograph
vibrate	pitch	stamen	volume
pendulum	parallel	pollen	thorax
symbol	computer	pistil	abdomen
pulley	property	connecting-rod	larva
gear	effect	gas	pupa
dissolve	protractor	negative	generator
invisible	dimension	diagram	botany
resistance	plan	analysis	ball-bearing
syphon	pressure	increase	section
compressed	indicator	barometer	piston
reflection	acid	ovary	cell
expand	contract	stigma	vacuum
eidophone	transparent	temperature	biology
friction	axle	thermometer	automatic
filter	shaft	valve	germinate
substance	crank	flow	decrease

The Brain



The brain is one of the most important parts of your body. It weighs between one and one and a half kilograms.

It uses 20% of all the blood in the body. It is carefully protected by the tough bone of the skull.

It has two main parts—the cerebrum and the cerebellum. They are divided by a deep groove down the middle into two halves—the right and the left half.

The numbers above show which parts of the brain control the following activities:

- 1. Tongue control 2. Thought 3. Speech
- 4. Hearing 5. Vision

Copy the drawing into your exercise books.

Plants and Light

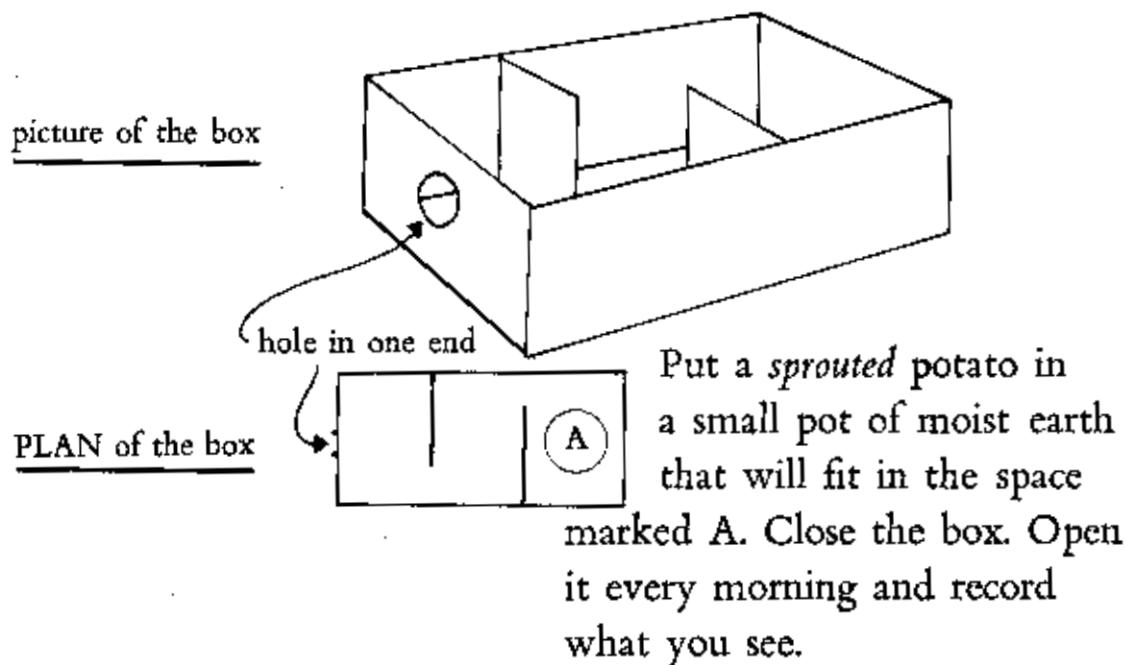
Do leaves need light in order to grow?

Have you ever seen plants growing in the dark?

Set up an experiment to find out whether plants can grow without light. Don't forget to grow some of the *same* seeds with light at the same time.

Another experiment

Make a box, out of cardboard, like this:



Another experiment

Put a bean in a tin of earth, and put it near a window.

Note which way the plant bends. Put another bean in another tin and shade it from the light on one side with a piece of cardboard. Note what happens.

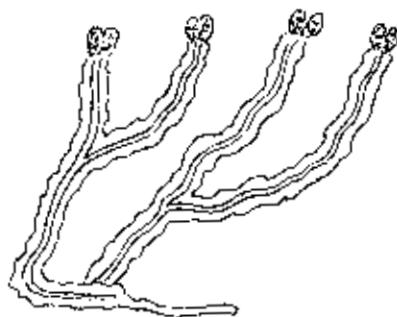
Plants without leaves

There are many plants in the world which do not have leaves.
Here are some of them:

Ferns	Toadstools	Mushrooms	Seaweed
Algae*	Lichens	Moulds	



Toadstool



Seaweed

Make a search in your neighbourhood for some of these flowerless plants. If you live by the sea you are lucky: you can find plenty of seaweed. But mushrooms and ferns and many other flowerless plants grow near villages and even in towns and cities; algae grow in water.

Try to collect as many as you can. Observe them, draw them in your books, and try to describe them as accurately as you can.

Do not eat toadstools, and wash your hands after touching them: some of them are very poisonous.

*Algae : pronounced 'aljee'

Surface Tension

The surface means the *outside part of anything*. A surface has length and breadth, but no depth. For example, the surface of your skin is smooth, the surface of a piece of sandpaper is rough. Tension usually means *stretching*, and in science it means the force inside something which is being pulled.

Water and other liquids have a thin film over the top of them. This film is tightly stretched over the top of the liquid. We call it surface tension.

Fill a glass of water to the very top. Look carefully. Can you see the film? Yes . . . or No . . .



Now take another glass, dry the rim of the glass with a piece of dry cloth, and fill the glass carefully, right to the top. If you are careful you can fill it so that the water is slightly higher than the rim of the glass. Now drop some 10-paisa coins

edgewise (not flat —————) into the side of the glass.

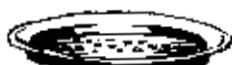


How many coins can you drop in before the water spills over the rim of the glass? Try again, but remember to dry the rim with a piece of dry cloth.

Surface Tension

Here are some more experiments to show that *surface tension* exists.

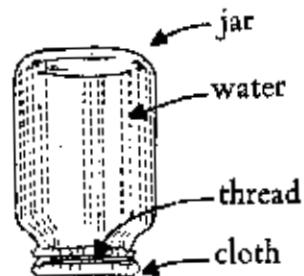
The Floating Sieve



Will a tin lid with holes in it float? Try it and see. Get a tin lid and punch some *small* holes all over the bottom with a *thin* nail. Now float it in a pail of water. Does it stay up, or does the water in the bucket come through the holes? Pour a little water into the tin lid. What happens now?

The Waterproof Cloth

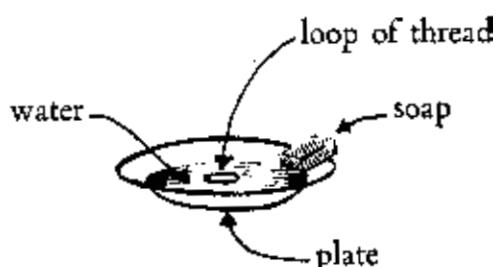
Get a glass jar and fill it with water. Get a piece of thin cloth, wet it well, and then tie it tightly over the mouth of the jar with string.



Turn the jar upside down. What happens? What happens if you rub your finger on the cloth?

The Soap and the Loop

Get a plate, and wash it in water until it is *very* clean. Fill the plate with water. Then make a small loop of thin cotton thread and float it on the surface of the water. Now touch the surface of the water at one side of the plate with a piece of soap. What happens? Why does it happen?

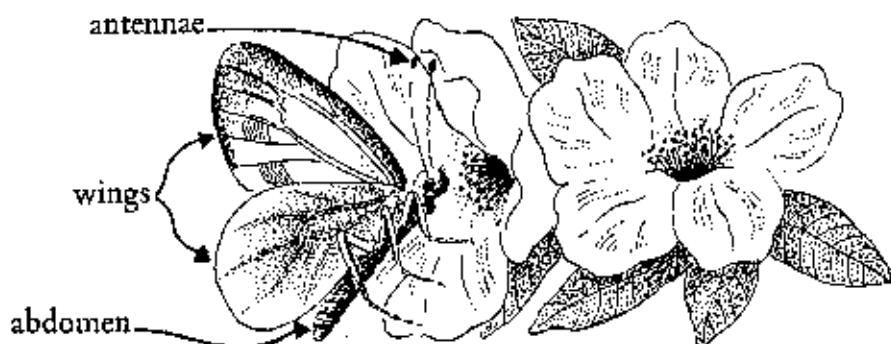


Butterflies

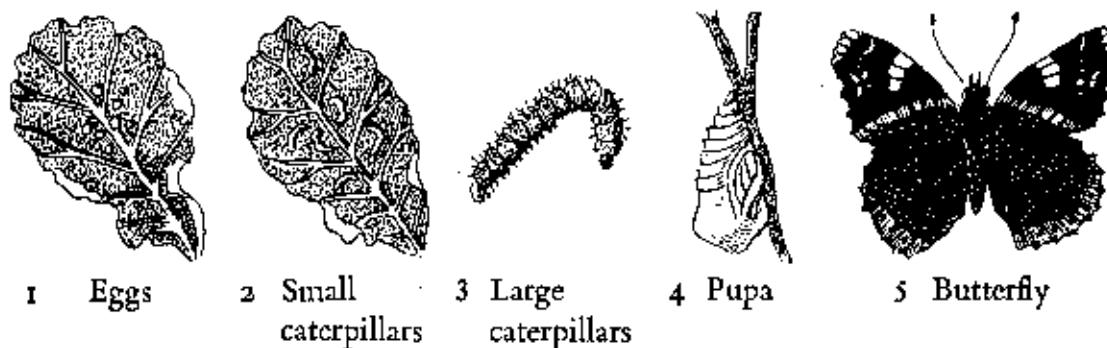
Do you remember what you learnt in Book 4 about insects?

Tell your teacher all you can remember.

(How many legs : larva : pupa : feelers : thorax, etc.)



The butterfly has four wings and six legs, two eyes and two feelers. It sucks sweet liquid (called nectar) from flowers with its mouth, which is like a tiny tube. It has no teeth and no tongue. The life-cycle is as follows :



If you can find the butterfly in stages 1-4, put the leaf or caterpillars in a glass jar. Cover the top with a piece of cardboard with *holes in it*. Give new leaves every day. Watch the caterpillar grow. Try to draw it and measure it every day.

Butterflies and Moths

Moths are very like butterflies, and it is often difficult to tell the difference. Remember these points:

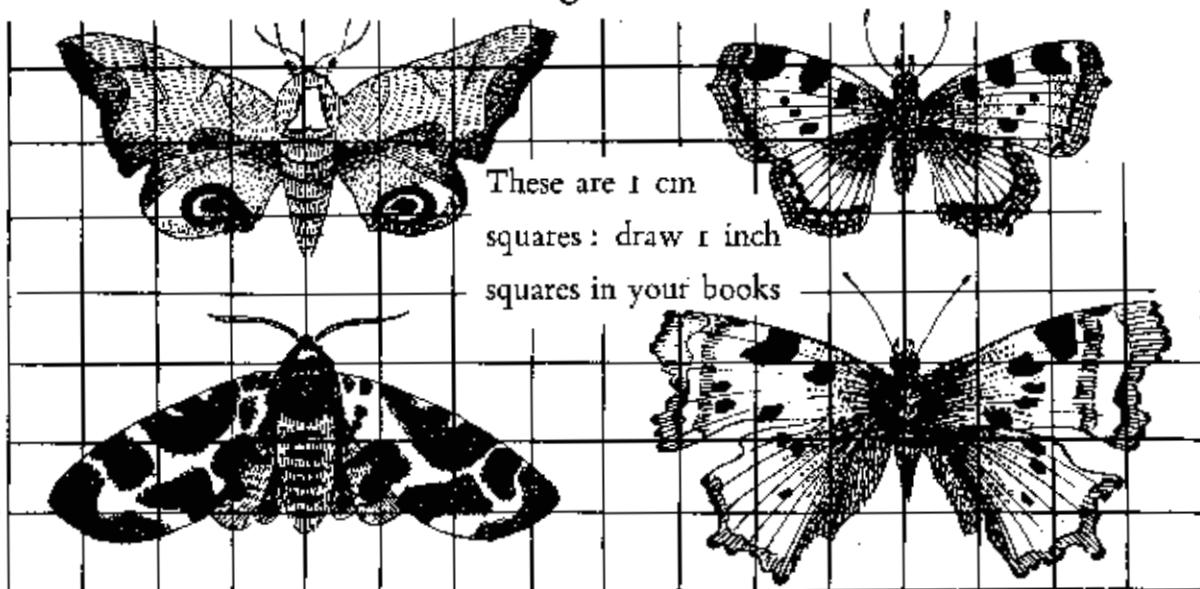
1. *Generally* moths can be seen at night and butterflies during the day.
2. The antennae* in a butterfly are clubbed; that is, they have a little blob on the end.
3. Butterflies usually rest with wings folded up, moths with their wings open and flat.

Watching them grow

Try to find a caterpillar. Keep it in a jar with a piece of card-board over it. The card should have holes punched in it for air. Stand the jar in a saucer of water, because if ants get into the jar they will eat the caterpillar. Feed new leaves every day.

Observe them carefully. Make notes of what you see.

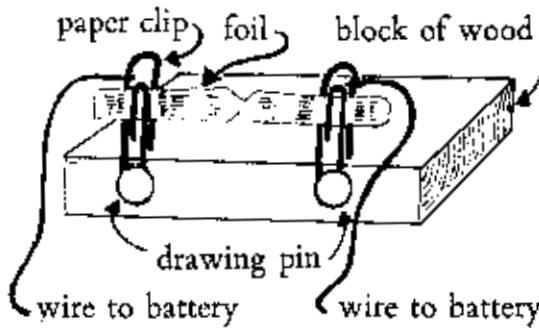
Enlarge these and copy them into your books. Cut them out of thin card, colour them and hang them on thin cotton thread.



* pronounced 'ant-any'

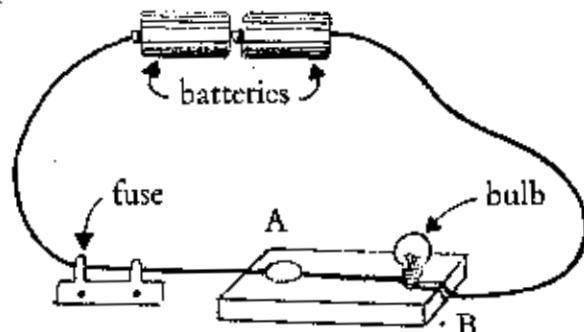
Fuses

Most electrical circuits are protected by a fuse. If anything goes wrong in the circuit (for example, two wires may touch each other), a fire might start. The fuse will prevent this: if two wires touch each other, the fuse will burn away and the current will stop flowing. The fuse is made of thin wire. You can make



a fuse for yourself. Take a piece of metal foil from a bar of chocolate and cut a strip about 7 cm by 1 cm. Cut a notch in it, and use two drawing pins, two paper clips and a piece of wood, as shown in the diagram.

Put two pieces of wire between the paper clips, and wire it in to your circuit:

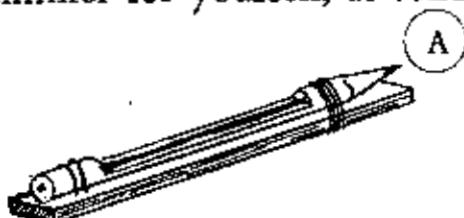


The bulb will light. Now touch another wire from A to B. This will cause a short-circuit, and the fuse of tin foil will burn through.

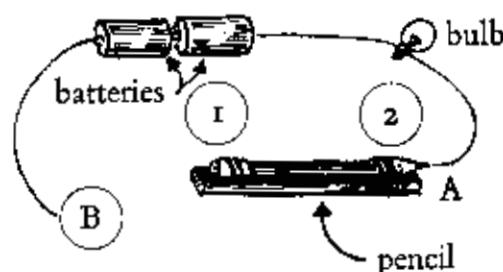
Ask your teacher to show you a larger fuse from the fuse-box in his house.

Light Dimmers

Sometimes in a cinema or theatre the lights go off very slowly—the light gets dimmer and dimmer. You can make a light dimmer for yourself, as follows:



Cut half of a pencil away, so that the lead of the pencil is showing, and tie it securely to a block of wood. Attach a wire to A, and then wire it into your circuit, like this:



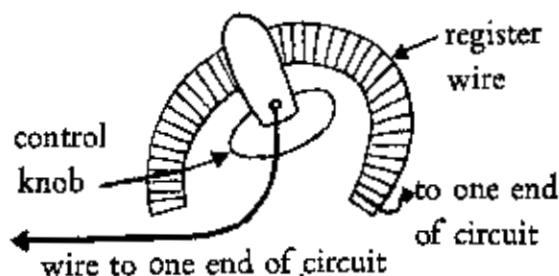
Leave the other end of the wire, at B, unattached. Now press the wire B (the end must be bare) along the lead of the pencil.

What happens? Does the bulb

burn more brightly when the wire is at (1) or at (2)?

The pencil lead here is a resistor. It resists* the current. The longer it is, the more it resists: so the longer it is, the less current flows through it, and the light burns more dimly.

The volume of sound which comes from a radio is controlled in the same way, but the resistor-wire is much longer. Because it is so long it is made into a coil, like this:



When the control knob is turned, the length of resistance wire is made longer or shorter; and therefore you get more or less volume of sound.

* *Resists* means 'tries to prevent'.

Designing a Torch

Think of a torch you have seen, either your own or one belonging to a friend or relation, and then write a description of it, make a drawing of it, and make a plan and section of it.

Now imagine that you are going to design a new kind of torch, *one that you can make yourself*.

First, list the important parts, e.g.

- (a) Connections from bulb to battery to bulb
- (b) Container for batteries
- (c) Bulb holder
- (d) Reflector
- (e) Switch

Think about (a) (b) (c) etc. in turn. *Write down* some of the questions about each, and then answer them.

For example:

Containers

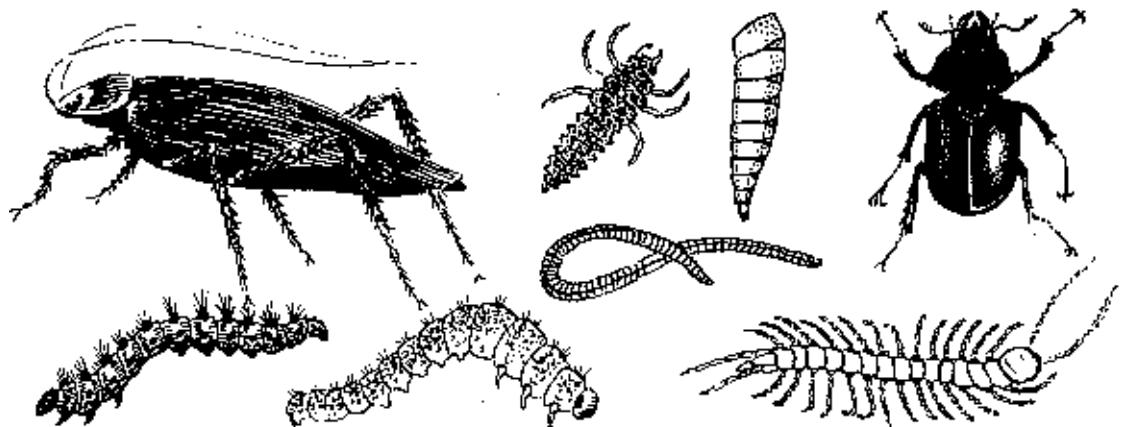
Do we need a container at all?

Could it be a shape different from the usual cylinder—a square box, a triangle (with 3 batteries), a circular box?

Could it be made of cardboard, wood, an empty tin can, papier mâché, cloth: what are the advantages and disadvantages of each material?

Then draw. Some suggestions are given on page 19. Make more drawings of your own. Then make your torch.

Observing Small Creatures

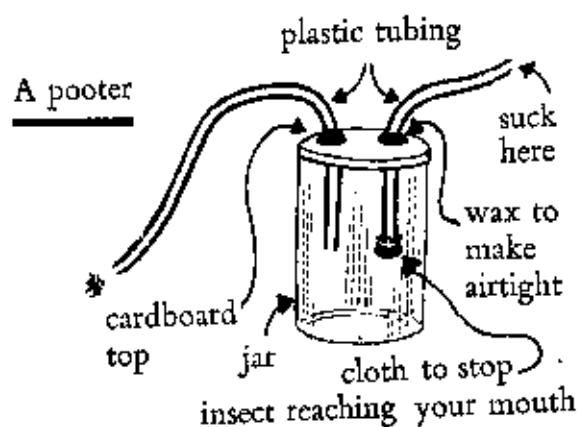
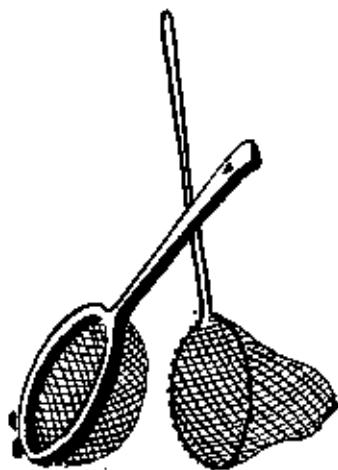


You can learn a great deal about small creatures by looking at them, and seeing where they live, what they eat, how they move.

Collecting

Make lists of likely places where you can find small creatures—rubbish dumps, the playground, the nearest pond, fields and parks, trees, your home, gardens, etc.

Water creatures can be collected with a net on a wire frame, or a kitchen strainer. Small insects can be caught in a pooter.



Observing Small Creatures

1. Collecting

Hunt for them, then collect them. Handle them carefully—there is no need to harm them if you want to observe them. Put them back in their homes, wherever you found them.

2. Questions you can try to answer

Where are they found? How do they move? What do they eat? What are they called? What do they do? Are they friendly? Do they sting?

Colours? Size? Weight? (How can you weigh ants?)

How fast can they go? How much do they eat?

Can they smell, see, taste or hear?

Do they grow? Do they change into something else?

Do they lay eggs? Do they make a noise?

3. Things to do

Try to keep them in suitable containers: give them the right kind of food, and air and water if they need them.

Make models of them (papier mâché from Book 4 and wire). Draw them. Observe and record what you see.



Plastics

Plastics are synthetic* substances which can be shaped in various ways by pressure or by heat. Make a small collection in the classroom by bringing some plastic articles from home. Compare the articles with similar articles made in the traditional way. For example, some of the things you might bring are combs, toys, bangles, bags and other containers, spoons, boxes, etc. Get your friends to bring things too. Then list them as shown below. Try to find out the information for column 4: you will have to do some tests. Some questions you could ask about the plastic articles are given below the list.

Name of Article	(A) Traditional Material	(B) Description of Plastic Article	(C) Advantages or disadvantages of (A) & (B)
Bangle	Glass	Thin coloured plastic, various designs	.....
Comb	.....	.....	.....
Bag	.....	.....	.....

Testing

You will have to *test* the articles in order to answer column 4. How would you test the following:

Does it break easily? Does it bend? or tear?

Can you cut it? Does it bend with heat? or melt?

For example, in order to test which *breaks* more easily, a glass bangle or a plastic one, you could drop a stone on each a number of times until one breaks. Start with a small stone.

Add another column to the list above, showing which article (plastic or natural material) you think is most beautiful.

* *Synthetic* means 'artificially made from chemicals: not from natural substances'.

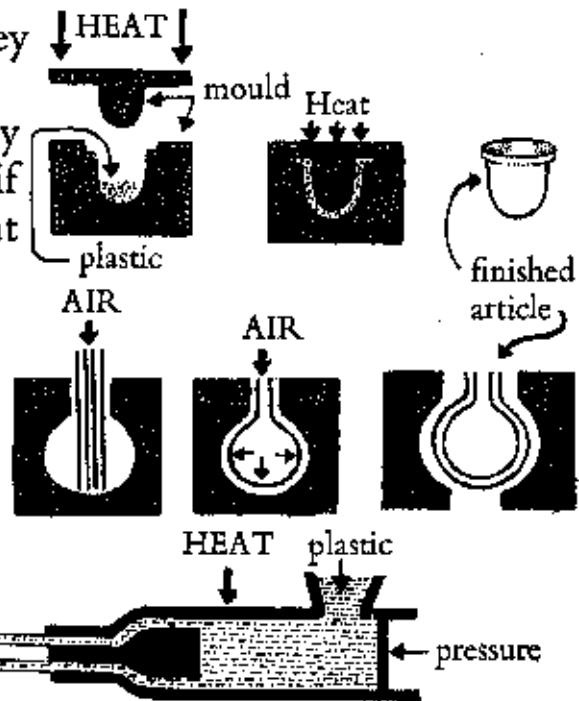
Plastics

As you learnt on page 22, plastics are synthetic substances. They can be moulded, or shaped in various ways, by *pressure* or by *heat*. There are two kinds of plastics:

Thermosets*: once they are shaped they can't be changed or reheated

Thermoplastics: can be reheated and reshaped a number of times.

Thermosets are heated until they become soft and runny. Then they are poured into moulds; they set when cool. Wax can be used if you want to try this process—heat the wax and press a coin into it.

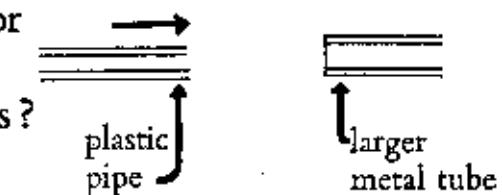


Thermoplastics

They can be moulded by blowing air into them. They can also be shaped by heating them, and then forcing them through a hole. Plastic pipes, for example, are made like this.

Try to design a machine of your own to make piping, on the lines of the one shown. What could you use for the plastic? Flour and water (dough)? or melted wax? Draw a plan of the machine, and list the difficulties you would find in making it. Get a piece of plastic pipe about 20 cm long. Heat it in very hot water. What happens to the pipe? Try to fit it on to a large metal pipe (a tap, for example). Will it go on? What happens to the pipe when it cools?

* *Thermos* in Greek means 'hot'.



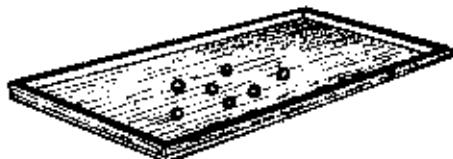
Molecules

Everything in the world is made of matter. We can say that *matter* is anything in the world that takes up space, or has weight.

Think of a bucket of sand. How many grains of sand do you think there are in a bucket? Millions! Now in each tiny grain of sand there are a large number of molecules. There are more molecules in a grain of sand than leaves on a tree. So you can imagine how small a molecule is.

Marbles in a tray

Take a tin tray and put six marbles into it. Roll the tray gently from side to side, and write down what happens to the marbles. Do all the marbles move at the same speed? What happens when they hit the side of the tray? What happens when they hit each other? Now put a bigger marble amongst the small marbles. What happens now?



Molecules are also bouncing about, just as the marbles do, in every substance. They pull each other, and push each other away.

Each molecule is made of atoms. We know that atoms exist, and we talk of Atomic Power, but atoms are so small that no scientist in the world has ever seen one.

Elements

An element is a simple substance which cannot be split into simpler substances.

For example, a cycle can be split up into a number of different substances. Try to list them in your books, for example : Iron, leather, rubber, . . .



How many bits of the cycle did you list? One of the substances used in a cycle is iron. We cannot split up iron into any simpler substances, so iron is an *element*.

There are more than a hundred different elements. Some of them you will know, e. g.

Iron, lead, zinc, gold, silver, copper and tin.

Brass, for example, which you see in brass mugs and other articles, is *not* an element. Why? Because it is made of two other simple substances, copper and zinc; they are not made of other simpler substances, so they are elements. You will have to learn the names of a number of elements for further work in Science. Here are some of the more common ones:

Aluminium	(Al)	Hydrogen	(H)	Silver	(Ag)
Barium	(Ba)	Iron	(Fe)	Sodium	(Na)
Boron	(B)	Lead	(Pb)	Sulphur	(S)
Calcium	(Ca)	Mercury	(Hg)	Tin	(Sn)
Cobalt	(Co)	Oxygen	(O)	Zinc	(Zn)
Gold	(Au)	Potassium	(K)		

Scientists use the letters in brackets, not the names. Some of the abbreviations come from the Latin names, e. g. *Ferrum* means Iron, *Plumbum* means Lead in Latin; so Fe and Pb.

Growing Things

Even if you live in a city, or if you have no garden near your house, you can still grow plants. Here are some ideas for indoor gardening.

Remember that such plants will :

- (a) Give you enjoyment.
- (b) Look beautiful.
- (c) Give you an opportunity to practise some of the skills which scientists use.

For example, when you grow plants :

- (a) *Observe* them carefully.
- (b) *Record* what you have seen, preferably every day.
- (c) Use graphs and charts to display what you have recorded.

Containers

You will need some containers to grow your seeds in :



plastic bags
of soil

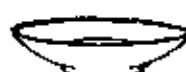


eggshells

flowerpots



empty ink
bottles



saucers



bamboos
cut at
joint



tins



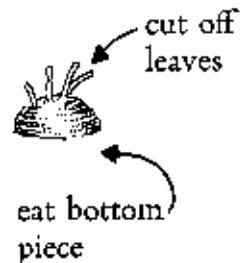
broken pots



glass jars

Growing Things

One of the easiest things to grow is the top cut off a carrot. Cut off the leaves, and eat the carrot. Before you eat it, cut the top 2 cm off, like this. Then place the piece of carrot in a tin or saucer of water, with a few stones to keep it upright. Record what happens.



Trees

You can grow small trees from lime pips, pips from oranges and lemons, papaya and grape seeds, *unroasted* groundnuts, and even from *unroasted* coffee beans.



Try different kinds of soil with seeds of the same kind.

Try different amounts of water.

Try shielding one of two plants from the light.

Try putting one plant on the roof or in the verandah and one plant out in the garden. Does it like the sun?

Keep all your containers of soil *moist* but not *wet*.

Note the number of days each kind of seed takes to germinate.

Observe. Record. Display the results.

First Aid

Aid means help. First Aid means help which you give to a person who is hurt or injured, *before* the doctor comes. A person who is ill or injured is called a patient.

First, some general advice:

Act quickly.

Try to stop people from crowding round the patient.

Send someone for a doctor as soon as possible, or carry the patient to the nearest doctor.

Don't move the patient if it's likely that he has broken any bones.

Here are some of the ways in which you can help people.

Remember: you are not a doctor. Give whatever help you can, then see that the patient sees a doctor.

Cuts Wash them in clean water. If you have some antiseptic put it on: if not keep the cut clean by covering it with clean cloth. If the cut is very deep press the cloth on tightly and try to stop the bleeding until medical help comes.

Bruises Put cold water on as soon as possible. Use a towel or handkerchief soaked in water.

Things in someone's ear Pour a little sweet oil into the ear, and perhaps the 'thing' will come out. If it does *not* come out, take the patient to the doctor. Do *not* try to take the 'thing' out with a piece of wire or wood.

First Aid

Things in the nose Tell the patient to breathe through his mouth, and take him to the doctor.

Choking Bend the head and shoulders of the patient down, and thump his back hard between the shoulder blades.

Electric shock Switch off the current if you can.

DO NOT TOUCH THE PATIENT, even if he is screaming. Push him away from the wire with a piece of wood: do not use anything made of metal.

Poison If the mouth of the patient is NOT burnt, give him strong salt water to drink, and that will make him vomit.

Insect stings Take out the sting if possible. Put on some solution made of water and washing soda, or water and baking soda.

Clothing catching fire Approach the patient with a cloth or blanket, wrap it round him and lay him on the floor and smother the flames.

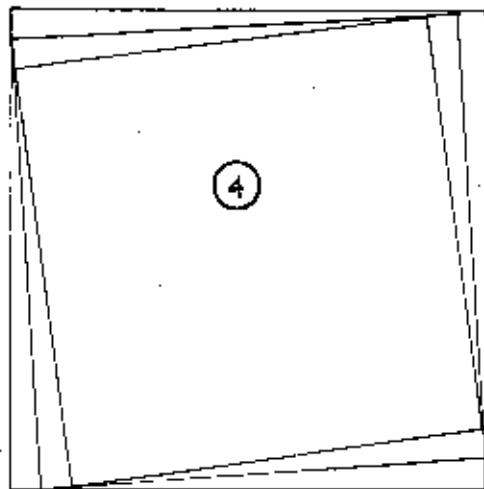
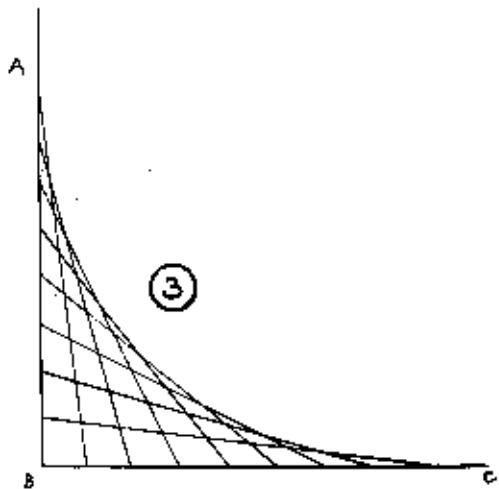
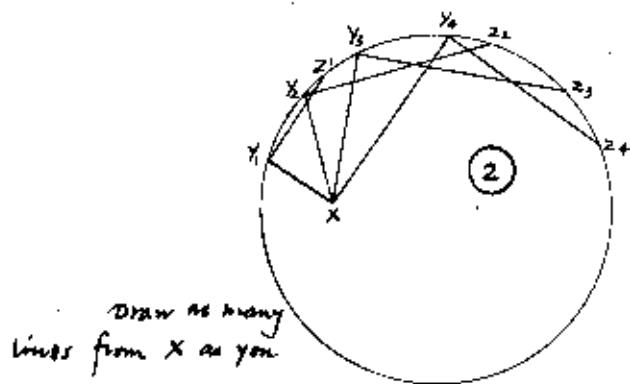
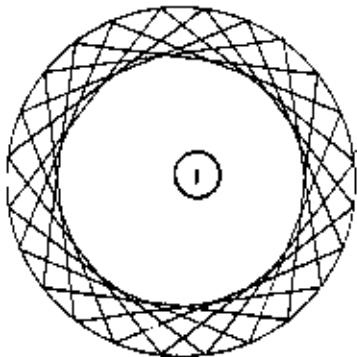
Burns Soak some cloth in warm baking soda or warm strong tea: dry the cloth and put it on the burn to *keep the air away*. Take the patient to the doctor.

Doctor, I'm ill!

You can play this game with your friends. Choose one by name, and say, for example, 'Dr Ravi, I'm ill.' Act your illness or injury: he will have to guess what your injury is and treat it according to the instructions above.

Curves

Use a pair of compasses, a ruler and a set-square to draw some of the designs below. Make similar designs using these ideas. Some *clues** are given at the bottom of the page.



1. All lines equal length.
2. Point X can be anywhere on diameter except centre. Angles XYZ all right angles.
3. A parabola : equal spaces on AB and BC. Try making ABC less than a right angle.
4. Complete the drawing: add squares until you get to the centre.

* Clue means 'that which leads you to find the answer to a question'.

Distillation

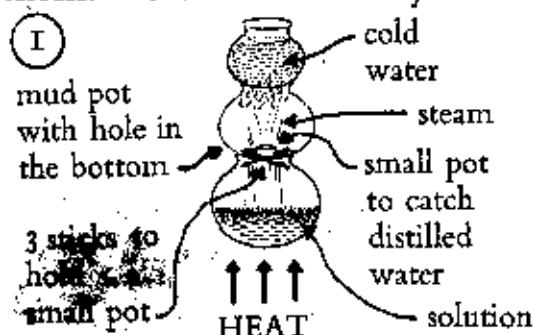
Distillation means making a liquid into a vapour, and then turning the vapour into a liquid again. Do you remember what you learnt on page 71 of Book 4 —about separating substances from each other? If we have a solution*, we can separate the solids and the liquid by distillation.

Making a Solution

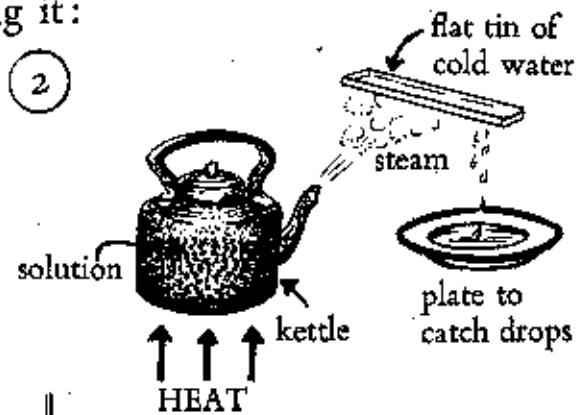
Try dissolving the following substances in water. If they do not dissolve, try heating them. Make a chart showing which substances dissolve without heat, which need heat, and which do not dissolve at all:

sugar salt sand earth flour pepper wood shavings
wax Epsom salts (called by chemists Magnesium Sulphate)
coffee tea chilli powder kerosene oil green leaves

When you have made your solutions, try to distil some of them. Here are two ways of doing it:



In (1) and (2) the principle is the same. The liquid turns into steam, the steam rises and condenses on the cold surface.



Don't forget to record your results: what is left when each solution has burned away?

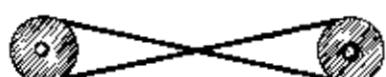
* *Solution* means a liquid with a substance dissolved in it, e.g. salt water.

Changing Direction

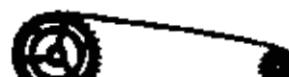
Very often engineers want to use power to make things move. Sometimes a machine goes up and down, but the engineer wants movement which goes round and round. For example, if you ride a cycle, you push *downwards* with your feet, but the wheels go *round and round*. You have learnt about some ways in which direction is changed in previous books. Do you remember these:



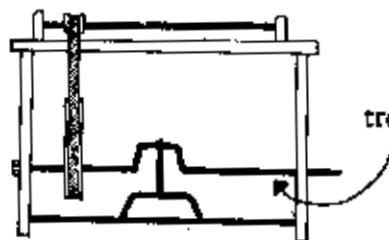
Pulleys
and belt



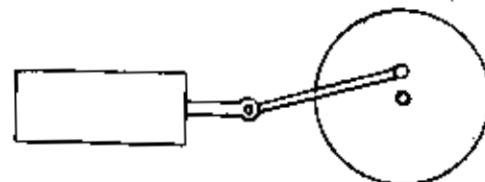
Pulleys
and x-belt



Gears and chain (cycle)



treadle (the lathe)



Piston and links (The Rocket)

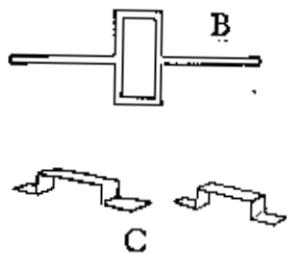
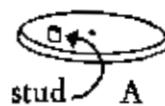
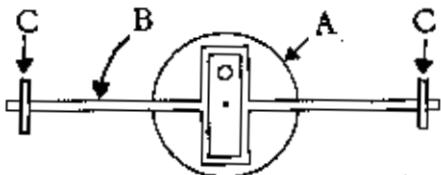
If you were designing a machine, how would you solve these problems :

- i Changing up-and-down motion to clockwise motion ?
- ii Changing anti-clockwise motion to clockwise motion ?
- iii Changing round-and-round motion to sideways motion ?
- iv Imagine you have built a windmill. How would you use the round-and-round motion to pull up water from a well ?

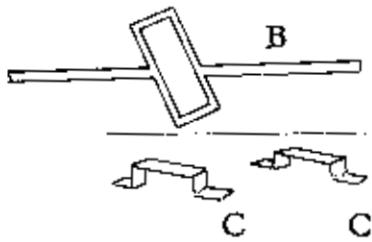
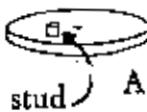
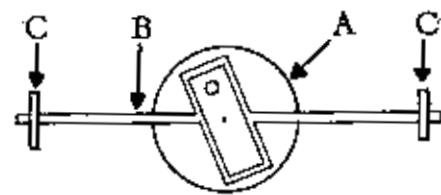
Draw diagrams to illustrate your answers to i - iv above.

Changing Direction

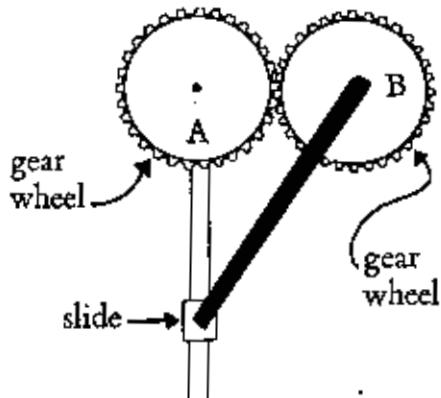
Here are three ways of changing direction:



(1) **Rectangular Cross-slide** Note that the stud on the wheel is not in the centre. If the wheel goes round, how does B move?



(2) **Oblique*** Cross-slide What is the advantage of this over the rectangular cross-slide?



(3) This is called **Watts Planetary Gear**. Watts was the name of the man who invented it. Describe how it works. What happens if A goes round? Why do you think it is called a planetary gear?

Try to make the linkages 1, 2, 3 above. 1 and 2 can be made of cardboard. What will you use as the stud? How will you make the gears in 3? Could you use the tops from lemonade bottles?

* *Oblique* means 'indirect, in a sideways direction'.

Observation and Concepts

In all the previous books in this series you have carried out a great number of experiments, made a lot of observations, watched things moving and growing and changing. This is the way in which we build up what are called concepts.

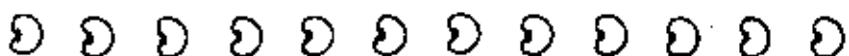
An example: imagine a very small child who has a dog called Jimmy. If the child sees a cat or a donkey he may call it Jimmy. But as he sees more and more animals he realizes that although each is different, they all have a number of things in common. So he builds up a concept—the concept of 'animal'. As we get more and more experience, and observe more and more things, our concepts change. For example, we start with a concept, 'animal'—something living but not human and then change the concept into a number of related concepts: flying animals (birds) and swimming animals (fish) and so on.

Once we have grasped the concept of animals, we can fit new creatures into it. For example, if we see some of the creatures in the picture shown here, we may fit them into our minds as animals, even though we have never seen them before.



Observation and Change

As we observe things, we can also observe differences between various things. When we observe differences, we can sort or classify things into different groups. We cannot sort things into different classes if there are no differences. For example:



We cannot sort the beans in a row *unless* some are big and some small, some old and some new, etc.

A great deal of our work in science consists in sorting things into different groups. How would you sort the following:

copper	milk	cow	coffee	brass	ear-ring	dog
(A) brick	stone	kingfisher	brasspot	knife	mouse	pin
piece of cloth	cup	ink	clock	boy	tree	silver?

Think first of the classes you could use. There are a great number—living and non-living—metals and non-metals—and many more. Sort them out in as many ways as you can. Put two headings, and list them under each heading.

LIVING NON-LIVING

Then make two more headings;
then two more. Could you
make 3 headings, or 4?

Scientists have to get used to asking a great number of questions. For example, which headings should I choose? What do I want to find out? Do I want to see which things are growing, or which weigh over 10 kg, or which will expand if I heat them?

Make lists of things similar to the list above at (A), and give them to your friends to sort into classes.

Patterns

You have already learnt something about patterns in previous books. Much of the work you will do in Science and Mathematics forms itself into patterns. Patterns help us to predict* what may happen in the future, or predict results we cannot see.

Looking at number patterns

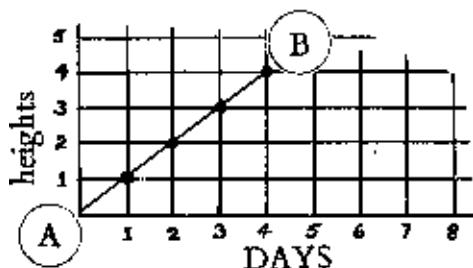
Make a chart with all the numbers 1—200 in order, as shown

1	2	3	4	5	6	7	8	9	10
11	12								
21									
31									
41									
51									
61									
71									
81									
91									
101									

in the diagram. Now take some beans, or small pieces of paper, and put on every 7th Square, i.e. one on No 7, one on No 14, one on No 21, etc, up to 70. Now look at the pattern of the number beans you have made. Can you *predict* what 17×7 will be from the pattern, without adding 7 more beans? Do the same thing with other multiplication

tables (e.g. 5×1 , 5×2 , etc.; 8×1 , 8×2 , etc.): see what patterns they make, and see if you can predict numbers above 100 from the pattern.

Growth patterns



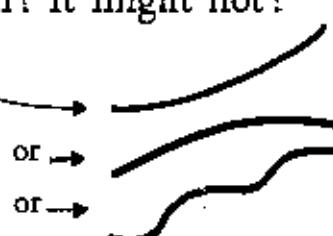
The graph shows that on the first day the bean grew 1 cm, on the second 2 cm, etc. You could easily predict the growth of the bean after 5, 6 or 7 days.

Would a bean follow this pattern of growth? It might not!

The line A-B might be like

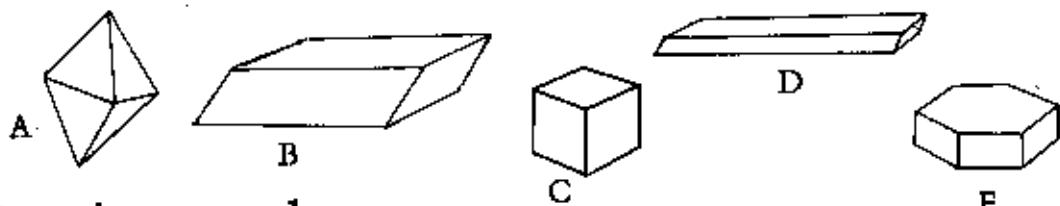
Grow some beans and see. Grow some green gram too. Do both sets of seed follow the same pattern of growth?

* *Predict* means 'to say that an event will happen'.



Crystals

A crystal is a regular arrangement of atoms in a pattern. You can see salt crystals (more easily with a magnifying glass): look carefully and then say which shape amongst the following is nearest to, or exactly the same as, the sugar crystal:

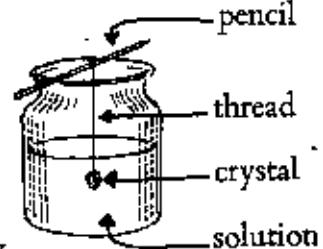


Growing crystals

If you make a salt solution and boil it, small salt crystals will form as the water evaporates. If you make a similar solution and leave it in a saucer (not in the sun) the water will evaporate by itself. Are the crystals different from the previous ones?

You can make bigger crystals out of Hypo (called by chemists *Sodium Thiosulphate*), which you can buy at the chemist's shop.

1. Make a saturated* solution by mixing hypo with water.
(Does the water get hotter or colder when you are making the mixture?)
2. Tie a crystal to a pencil with thin cotton thread and suspend it in the solution.
3. Put it *in* the solution every day at midday: take it *out* at 6 a.m. next day.

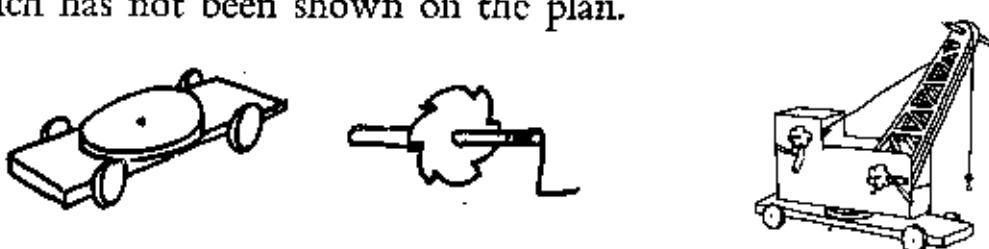


Try making crystals of salt (suspend a small washer in the solution), sugar or alum.

* *Saturated solution* means 'a solution which has so much of the thing dissolved in it that no more can be added'.

Model Crane

On this page and page 39 you will find pictures and plans of a model crane. Note that the plans on page 39 are not full size. Draw lines on a piece of paper, 1 inch apart, and then enlarge the patterns on page 39. The patterns should then be traced on to *thick* card (or 2 or 3 pieces of thin card stuck together). Make the cabin first and then the arm F. Note that the two pieces (G) which hold the two pieces of the arm F apart are placed as shown in the diagram. You will also need a separating piece at the top, between the two narrow ends of the arm F, which has not been shown on the plan.

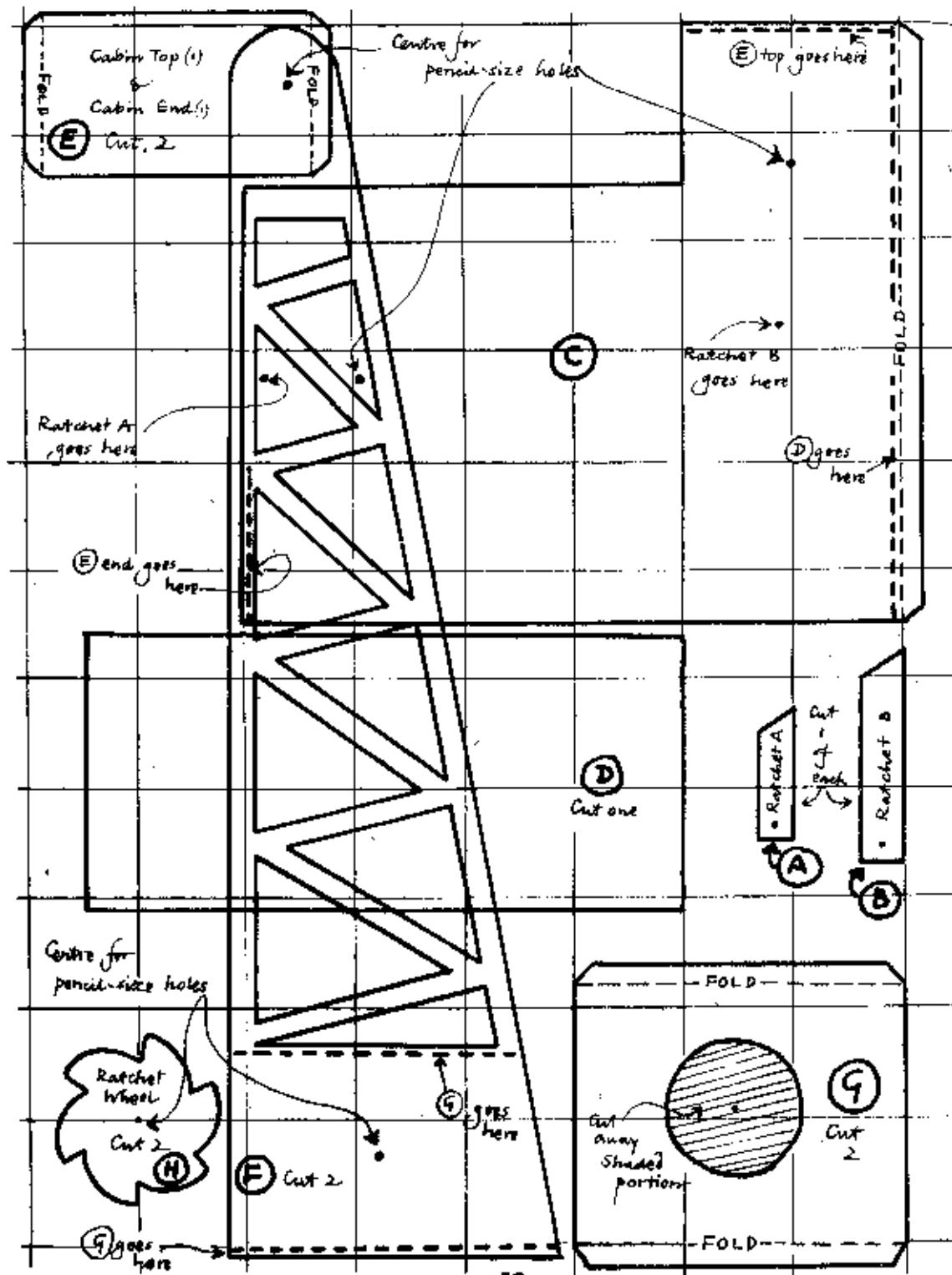


If the structure is not rigid add a few extra cardboard supports at the side.

The base can be made of cardboard in the same way as the cuboids you had made in previous books with a turn-table and wheels.

The ratchet wheels should be 2 or 3 thicknesses of cardboard stuck together; copy the plan on page 39 and cut the wheels carefully. The positions for these wheels are shown on the drawings and holes should be bored to suit a piece of pencil. The ratchets A and B are fitted as shown and held in place with an elastic band so that the wheel can only go in one direction. String is attached to the arm frame about half way up and then goes on to a pencil at the side of the cabin. Another string is attached to a pencil at the front side of the cabin. The ratchets will hold the arm and the weight in position while the whole crane moves to any position required.

Model Crane



Ecology

You learnt something about Ecology in Book 4. The word ecology comes from a Greek word *oikos*, which means a house or dwelling. Ecology means studying living things in relation to their surroundings. Another word which means surroundings is environment.

Only man goes everywhere in the world. No other creature does. Where do you think the following creatures are found:

lions, tigers, bees, ants, whales, flies, Polar bears, snakes?

Use your atlas. Make a note of places where these creatures are *not found*. How will you find out? (Dictionary, commonsense, encyclopaedia*, your parents, your teacher—discuss your answers in class.)

All creatures are affected by their environment.

All creatures are affected by other creatures.

How are the following affected by their environment:

a chameleon, a bee, a swallow, a mosquito?

How are the following affected by other creatures:

deer, frogs, cats, fish, worms, ants?

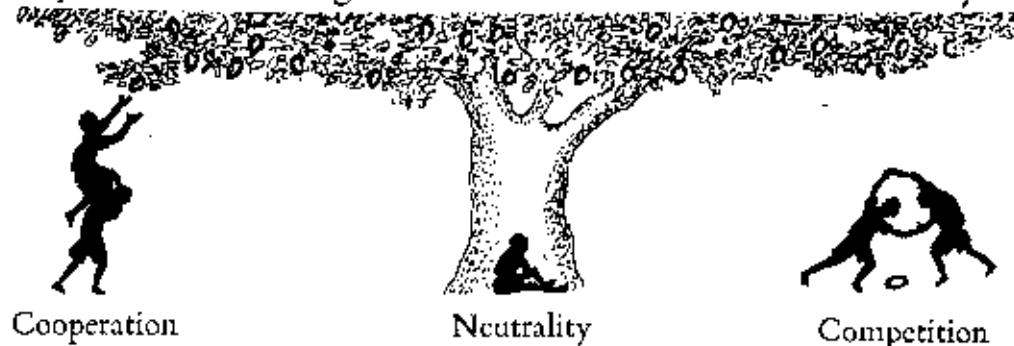
Think of ways in which *men* could change the environment for the creatures in both lists. Give at least one way for each creature. For example, the environment for deer could change if men burnt all the forests and built towns in their place.

* *Encyclopaedia* means 'a book which tells you about all branches of knowledge. It is arranged in alphabetical order'.

Ecology

There are three main types of relationship* between creatures.

They can compete	.....	competition
They can help each other	.....	co-operation
They can do nothing to each other	.....	neutrality



Most creatures have at least one of these kinds of relationships with other creatures. Give examples of *each kind* of relationship between the creatures listed below and any other creatures:

birds, dogs, boys, Army Generals, teachers.

Natural Cycles

Sometimes a number of happenings which *cause* each other is called a cycle:



rain tree deer lion vulture soil tree again

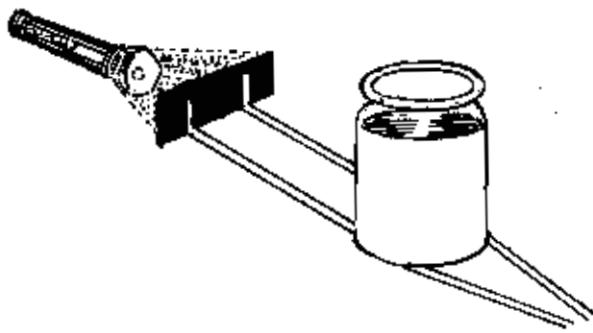
Draw some pictures of natural cycles of your own, and write a sentence about each saying how each stage is caused. Some suggestions to begin with:

- (1) food—fly—frog
- (2) grass—cow—milk
- (3) rock—wind—soil Continue each cycle to the end.

* Relationship means 'the way in which people have an effect on each other'.

Lenses

Take a jam-jar, and fill it with water. Cut two slits in a piece of card, as shown in the illustration, and put a torch behind the card. See the direction of the rays of light through the slits. Where do they meet? Do they meet at a different point if you move the card? or if you move the light?



The jar of water acts as a lens. Lenses are usually made of glass—you will see them in a pair of glasses, in a telescope, a microscope and a pair of binoculars. Write the names under the pictures:



Lenses are made of glass.

If the section is  they are called convex.

If the section is  they are called concave.

The rays go through a convex lens like this

Draw rays going through a concave lens.

Ask your teacher to show you a lens.

Thinking

Scientists have to do a great deal of thinking. Here are two very important words connected with thinking:

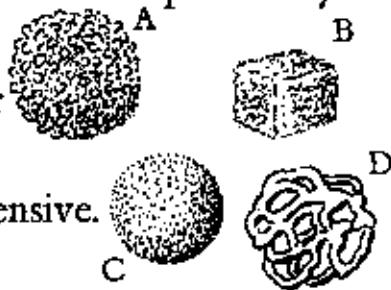
SUBJECTIVE and OBJECTIVE

A subjective opinion is one which is based on the speaker's feelings. An objective opinion is one which can be proved by demonstration or experiment.

For example : I asked Ravi about the four sweets shown in the picture. He said :

A is the biggest. C is the most expensive.

B is the smallest. D is the best.



Do you agree ? It's obvious that Ravi's remarks about A, B and C can be shown to be correct ; A and B can be measured ; the sweetmeat-maker will tell us if C is the most expensive. His remark about D is subjective ; he may think it is the best, but you may not.

When you read books you should be careful to see whether the writer of the book is making objective or subjective statements : sometimes writers pretend that statements are objective when they are not. Which of the following statements do you think are objective ?

Water boils at 100°C . Brass is made of copper and zinc. Brinjals are the tastiest vegetables. Tigers do not live in the Arctic regions. Kalidasa is India's greatest poet. Mount Everest is the highest mountain in the world. My hair is longer than yours. Milk boils faster than water. Teakwood is heavier than Red Cedar. A clock which has stopped shows the correct time more often than one which gains 5 minutes every twenty-four hours. Write 5 objective and 5 subjective statements of your own.

Statistics

Statistics means facts shown by numbers. What facts about Ravi do the following statistics show?

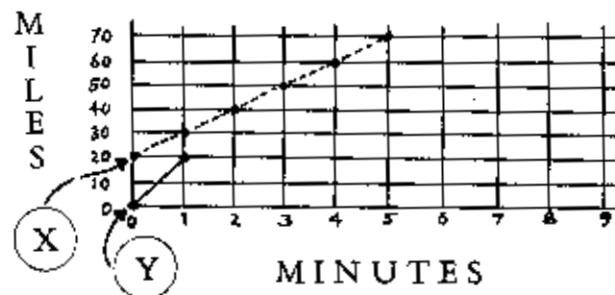
(A) Name	Height	Weight	Age
Nirmala	120 cm	25 kg	9 years 2 months
Ashok	129 cm	24 kg	9 years 4 months
Uma	115 cm	21 kg	9 years 3 months
Ravi	131 cm	26 kg	9 years 1 month

We can say that although Ravi is the youngest, he is the tallest and the heaviest.

Sometimes scientists show facts in a graph. This not only makes the facts clearer, but sometimes allows us to predict, or say what a new fact will be. For example:

One aeroplane (X) goes at a speed of 10 miles a minute, and a second plane (Y) goes at 20 miles a minute. The slower plane has a start of 20 miles. The graph would look like this:

(B)



Can you predict

- When they will meet?
- How far apart they will be after 5 minutes?

Make 2 tables like (A) above

- Showing the time taken to run the length of the playground by 5 different boys; give ages and heights too.
- The names and heights of 5 trees.

Make 2 graphs, as in (B) above.

- 2 cars
- 2 boys

Choose your own speeds: in each case give a car or a boy a start over the other.

Does Science Help People?

Discuss with your teacher and your friends the following points:

1. Which branches of Science do you think are most useful to mankind?
2. How does the study of the following things help people?

Write two sentences about each:

Botany, the use of friction, electricity, magnetism, metals, chemistry, wind pressure, the brain, muscles.

Have you ever heard of the Nobel prize? Alfred Nobel was born in 1833. He was a Swedish chemist, and he invented dynamite. He made a lot of money out of his inventions, and as he had no family he left the money for prizes in physics, chemistry, medicine and literature. He also left money for a Peace prize for men who help the cause of peace.

Is dynamite good or bad?

It can be used for good purposes, such as blowing up rocks to make dams, or wells.

It can be used for bad purposes, such as making bombs.

Scientists often discover or invent things which can be used in good ways or bad ways.

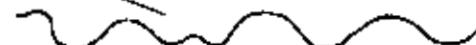
Write two sentences about each of the following, giving one good and one bad use of each. Will your sentences be subjective or objective?

guns, aeroplanes, ships, poisons, television, radio, petrol.

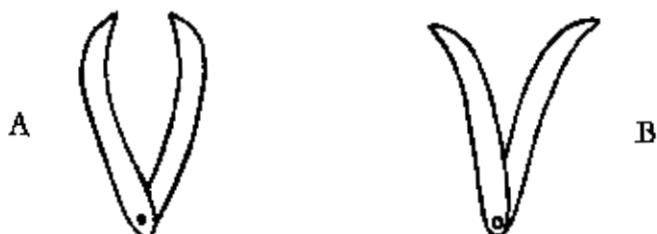
Measuring Things

How would you measure this line? _____

How would you measure this angle? 

How would you measure this line? 

Here are two more instruments for measuring. They are called callipers*



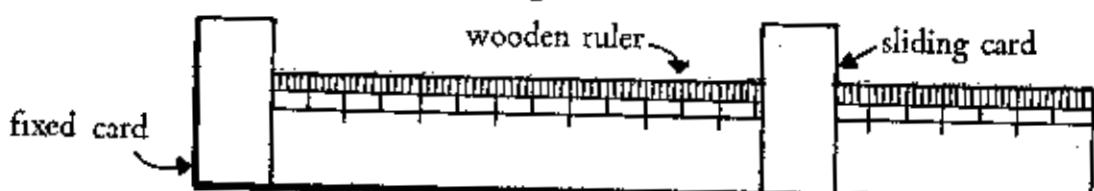
We can use them for measuring things like this:



One is called Inside Callipers and one Outside Callipers.

Which is which, A or B? Why do they have these names?

You can also make a measuring instrument like this:



You could use this for measuring the thickness of rods.

Try to make all the three measuring instruments shown on this page. How would you join the two legs of the callipers?

* You can spell it *calipers* if you wish.

Bird Models

Do you remember the bird models you made in previous books?
They were:



The Hoopoe



The Pied Wagtail



The Tailor Bird



The Kingfisher



The Parakeet



The Bee-Eater

On the next two pages are two more models. Trace the pictures.
Do not cut the book. Then make new drawings on clean white paper.
Do not trace the numbers, lettering or shading: they are
to tell you what colours to use and where to stick the models
together.

Follow this order of work:

Trace.

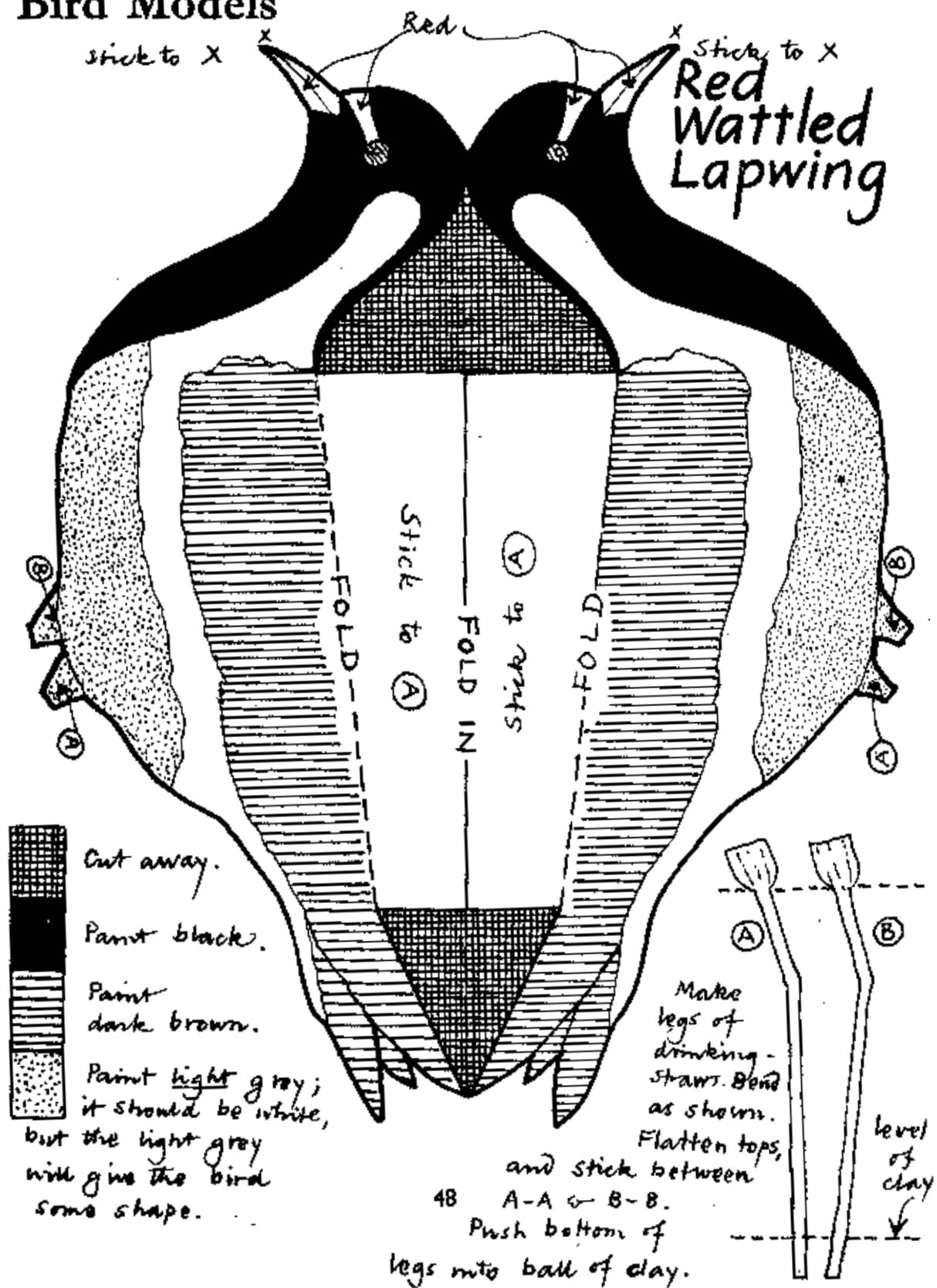
Put on white paper.

Paint with the correct colours.

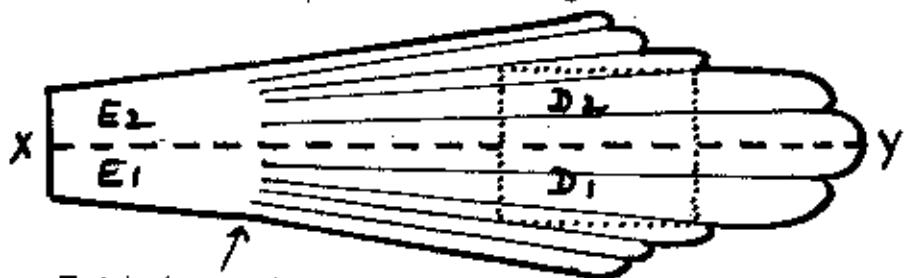
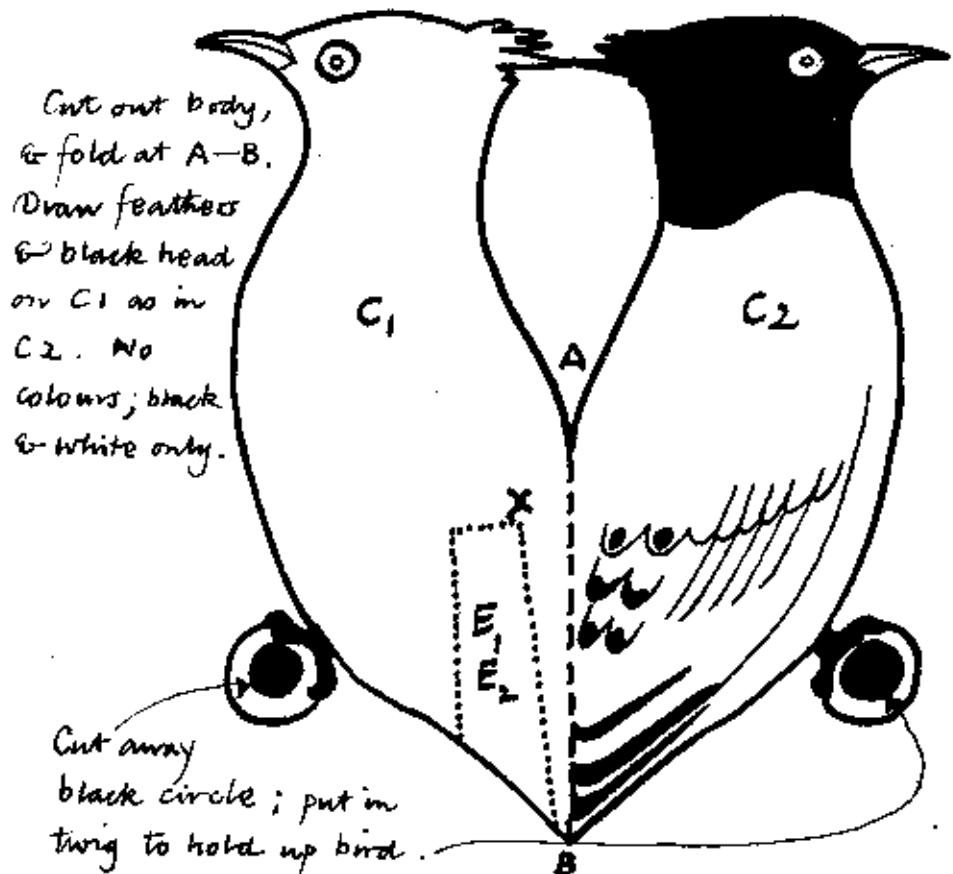
Cut out carefully.

Stick where required. (Use cooked rice or paste.)

Bird Models



Bird Models



Fold tail at X-Y, and stick streamer ⑨ so that D₁ & D₂ are in the position shown by the dotted rectangle. Stick streamer and tail between C₁ and C₂ in position shown, X at X.

⑨ Streamer: fold at F on dotted line.

Paradise Flycatcher



Energy

You all know the word energy. Sometimes we say about a person, 'He has a lot of energy.' Energy means force, or power, or the ability to work. One scientist described energy as 'the "go" in things'. Scientists also tell us that the sun is the source, or cause, of all energy. How does the sun light a bulb or kick a football? Well, of course, it doesn't: but it is the first cause. Look at these chains:

Sun—heat—water into clouds—rain—vegetables—food—strong legs—kicking a football.

Sun—rain—rivers—hydro-electric power—current—bulb.

Here are some sources of energy:

Heat	Electricity	Water	Wind	Human power
Sound	Magnets	Gravity (e.g. rolling down a slope)		
Light	Springs and rubber bands			

Very often we want to convert* energy. For example, we light a fire under a boiler, and convert the heat into movement (a steam train): or water moves in a river and we convert that movement to a round-and-round movement of the wheel.

Try to write down at least two things which 'go' because of one of each of the sources of energy above. Then give two examples of conversion for each. For example:

Sound to Movement (do you remember the eidophone in Book 3, page 19?); or Human Power to Heat (this is a difficult one).

* *Convert* means 'to change from one state to another'.

Energy and Change

Nothing changes without energy.

Energy means change.

In Books 1-4, and in this book too, you have done many experiments, made many things, observed many things happening. In everything you did, a change took place. Think of these things :

Boiling water, using levers, making a paper bird
these are only a few of many cases. We might say that science is the art of observing changes.

When you are observing change, what things should you look for ? Here are some of them :

- (1) What changes—matter (e.g. chapati dough) or non-matter (e.g. your ideas) ?
- (2) Can it be changed back again ? e.g. if you boil water it can be changed back again (steam to water).
- (3) What caused the change ?
- (4) Was it a fast change or a slow change ?

Write answers to these questions about some of the changes below :

Plants (small to big). Animals. The change in position of a dead leaf from your garden to mine. Curds. The temperature (night and midday). Rocks to sand. Egg to bird. Rock to soil

Food

Do you remember what you learnt in Book 4 about food in the stomach? The food passes down into the stomach, and part of the food is absorbed* into the blood stream. The rest of the food, which is not used by the body, is sent out as waste matter (faeces, pronounced *feesees*, which is solid waste matter, and urine, pronounced *yure in*, which is the liquid waste matter).

The body, just like a steam engine, burns up food to give it energy. The *amount* of heat produced by food is measured in Calories. Even when we are asleep we need Calories, just as an engine burns coal even when it is in the station and not moving. When we work, we need more Calories; the harder we work, the more Calories we need. Here is a table showing how many Calories a man needs every day:

<i>Activity</i>	<i>Calories needed every 24 hours</i>
Resting in bed	1,800
Sitting and reading	2,500
Light work	3,000
Heavy work	4,000



We cannot get energy from the sun, but only from food. Plants can turn the sun's energy into food, but we cannot.

Food gives us very important things. Some of these are:

Proteins Fats Carbohydrates Vitamins

**Absorb* means to 'drink in'. Blotting-paper absorbs ink.

Food

Proteins, Fats and Carbohydrates all give us Calories.

One gramme of Protein gives	4 Calories
One gramme of Fat gives	9 Calories
One gramme of Carbohydrates gives	4 Calories

You might think that if we are going to do light work, for which we need 3,000 Calories, we could eat about 300 grammes of Fat and that would be sufficient. Unfortunately our bodies do not like a diet consisting of fat: they like a diet consisting of

1 part Protein
1 part Fat
5 parts Carbohydrates

Many foods give protein, fat, carbohydrates and vitamins too. Here is a table showing foods and what they give:

Food 100 gm	Protein in gm	Fat in gm	Carbohydrates in gm	Calories for each 100 gm
Chapati	5	1	47	225
Ghee	—	93	—	865
Milk	3½	4	5	72
Eggs	12½	10½	—	150
Sugar	—	—	100	410
Bananas	½	½	14	65
Chocolate	4½	31	60	555

Food

Let's summarize what we learnt on pages 52 and 53.

We need Calories every day (about 3,000).

We need a diet which gives us

Proteins, Fats and Carbohydrates

in the proportion of 1 part Protein

1 part Fat

5 parts Carbohydrates.

We also need Vitamins. The common ones are:

Vitamin A from cream, butter, eggs & green vegetables.

Vitamin B complex from fresh milk, eggs and sprouted gram, unpolished rice.

Vitamin D from the same things as Vitamin A.

Vitamin C from oranges and limes, germinating pulses, fresh milk, fresh vegetables.

Problems

Write down what you eat every day. Try to calculate how many Calories you take in, and how much fat, protein and carbohydrates. Do you get enough vitamins?

For vitamins, remember these points:

- (1) Drink some milk every day.
- (2) Eat fresh vegetables.
- (3) Eat sprouted green gram (cover the gram with wet cloth for 24 hours and sprouts will appear.)
- (4) Eat oranges and drink lime juice.

Heat Changes

Do you remember what you learnt on pages 50 and 51?

No energy without change: no change without energy.

Change means a difference. Sometimes the change is permanent, and the difference always remains: for example, if you boil an egg, the yolk and white cannot be changed back to what they were before. Sometimes changes can be reversed: for example, water can be changed into steam, and then the steam can be changed to water. What kind of changes are the following, reversible or permanent?

Boiling an egg

Cooking a chapati

Making tea

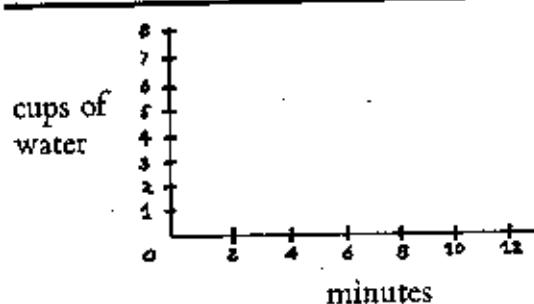
Heating a wax candle

Burning a piece of paper

Burning your finger

Bending metal by making it red hot

Recording a heat experiment



Experiment with trying to *boil* water. Use the *same* cup and the *same* amount of heat. Fill in the graph points by guessing: then boil the water and see if you were correct. Could you

predict from such a graph how long it would take to boil 16 cups of water?

Another experiment

Heat some sugar in a tin lid and write down what happens.

A puzzle

Why does milk boil over while water does not?

Astronomy

Astronomy means the scientific study of the stars. Have you ever studied the stars? You have learnt about some of the constellations in previous books: on page 57 you will find some of the well-known ones.

An experiment

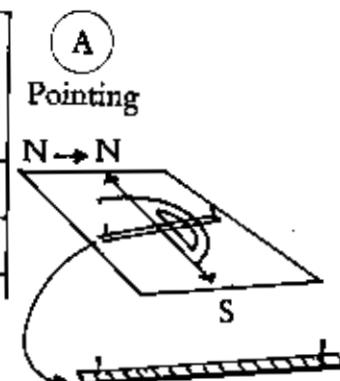
Try to observe one star for a few weeks. For example, take one of the stars of the Plough. Look at page 57. Can you see the star α in the Plough. (α is the first letter of the Greek alphabet, and corresponds to *a*. The brightest star in each constellation is called α .) You could fill in a chart like this:

Time	Position N S E W by compass	Inclination in degrees	Date
7.0 p.m.			
9.0 p.m.			

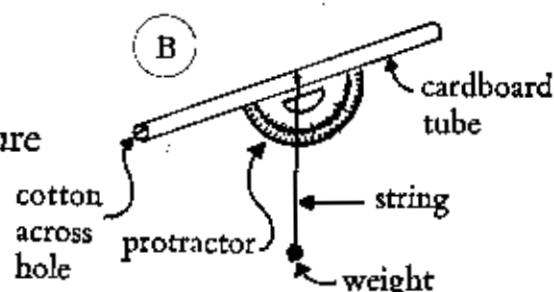
You will need two instruments for these readings.

You can make them easily by using a protractor. (A) will show you the compass direction, but you will have to find the Pole Star first, or use a compass (you made one in a previous book).

For the other (B), you must be sure that the tube is level with the straight edge of the protractor. Sight the star through the tube and read the degrees.

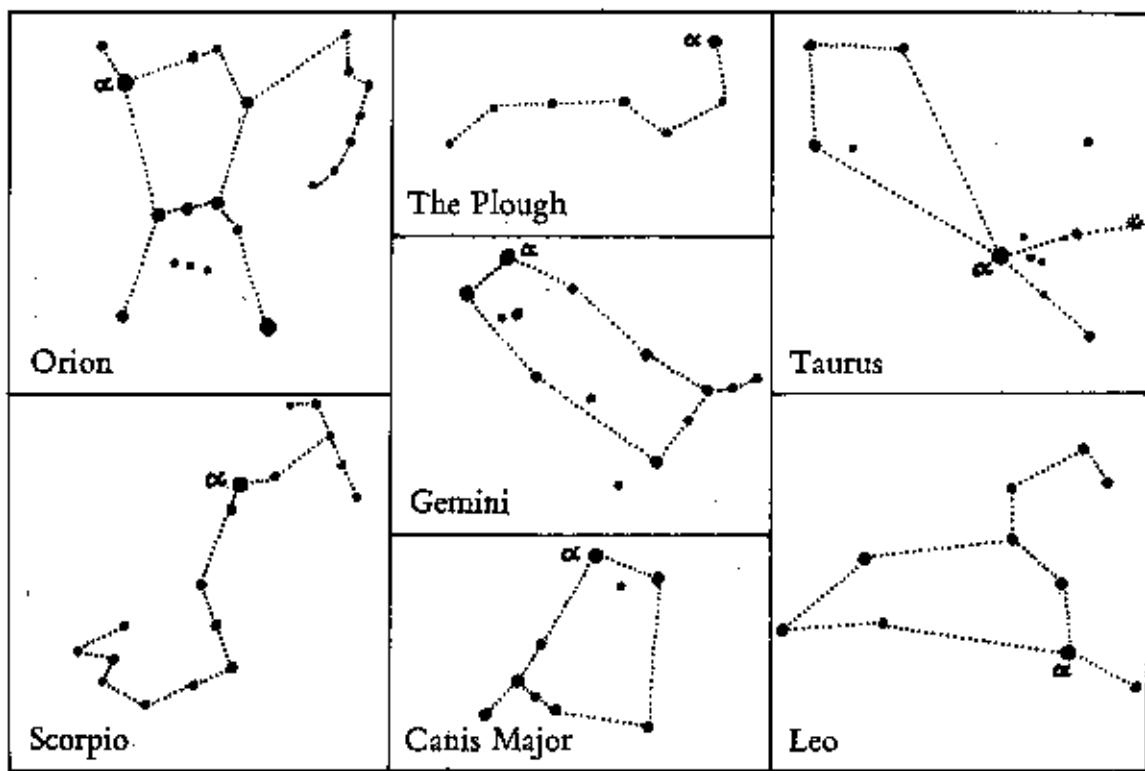


Ruler with 2 pins
Make sure both pins
and star are in line.
Then read degrees.



Astronomy

Here are some of the well-known constellations:



See if you can find these shapes in the sky. Some can only be seen in the winter, some in the summer, some at all times of the year. If you make regular notes, you will see how they change their positions.

Some of the stars are very big.

The big star in Orion (α) is called Betelgeuse (pronounced Beetle-jooz).

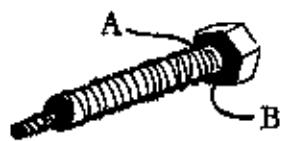
The earth is 7,927 miles in diameter.

The sun is 864,000 miles in diameter.

Betelgeuse is 300 *million* miles in diameter.

An Electric Buzzer

Do you remember the coil you made in Book 3? It consisted of a 3" bolt, with many turns of wire wrapped round it. Do you remember what happened when you connected A and B to a battery? The bolt then became a magnet.



Here is a buzzer you can make. It works like an electric bell, except that when you press the switch it buzzes instead of ringing. You will need:

- A bolt (about 10 cm by 1 cm thick)
- 100 gm insulated wire (20 or 22 S.W.G.*)
- Two pieces of tin 2 cm by 10 cm
- Two small pieces of wood
- A screw-eye or screw
- A rubber band
- A nail or two
- A flat piece of wood 15 cm x 15 cm x 2 cm

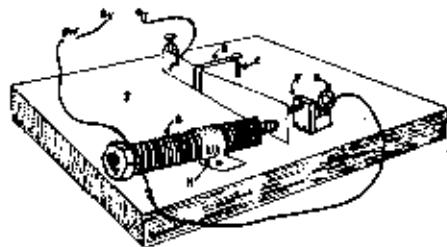
(All measurements are approximate†.)

First, look carefully at the drawing on page 59. Look at it for at least 5 minutes; try to make it in your mind before you read the instructions. Try to answer these questions: What do the letters By and Sw stand for? How do you wind the wire on to the bolt? What are A and H made of? (Look at the list of things at the top of this page.) How will you fix F to J? How is D fixed to A? How is the wire fixed to A? Write answers to these questions *before* you read the instructions.

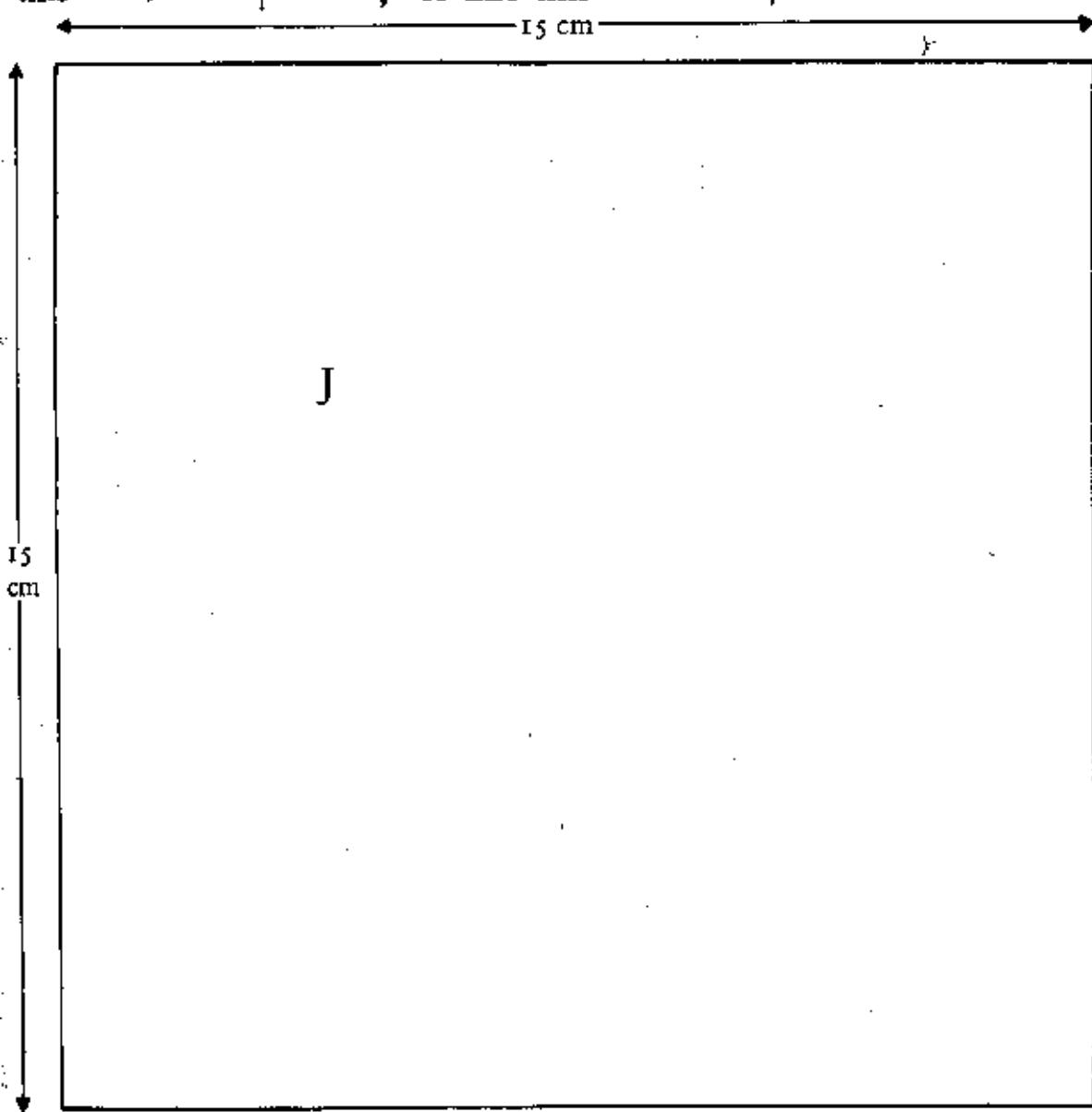
* S.W.G. stands for 'Standard Wire Gauge', and tells us the diameter of wire. 100 gm of 20 S.W.G. will give you about 20 metres of wire.

† *Approximate* means 'not exact'.

An Electric Buzzer



Draw a plan of the buzzer, on the diagram below. The outline of J (the piece of wood) has been given for you. Note that the screw G, the piece of tin A and the end of the bolt B are never all three touching at once. They are either like this →  , or like this → 



An Electric Buzzer

Instructions for making it : Wind some paper on to the bolt, and then wind on all the wire. Let the two ends of the wire come from the end nearest the head. This is B : fix it to the board with a piece of tin H and two nails. Twist the piece of tin A round the nail E, and fix the wire from the battery to it, by forcing the bared wire through a slit in the tin. Join two pieces of wood to make F, and fix in position with two nails. Make a hole and put the screw-eye G through it. Fix the rubber band D over A and then on to the nail C. Join the wires *as shown* : one wire from the coil to G : one wire from the coil to Sw : one wire from A to By.

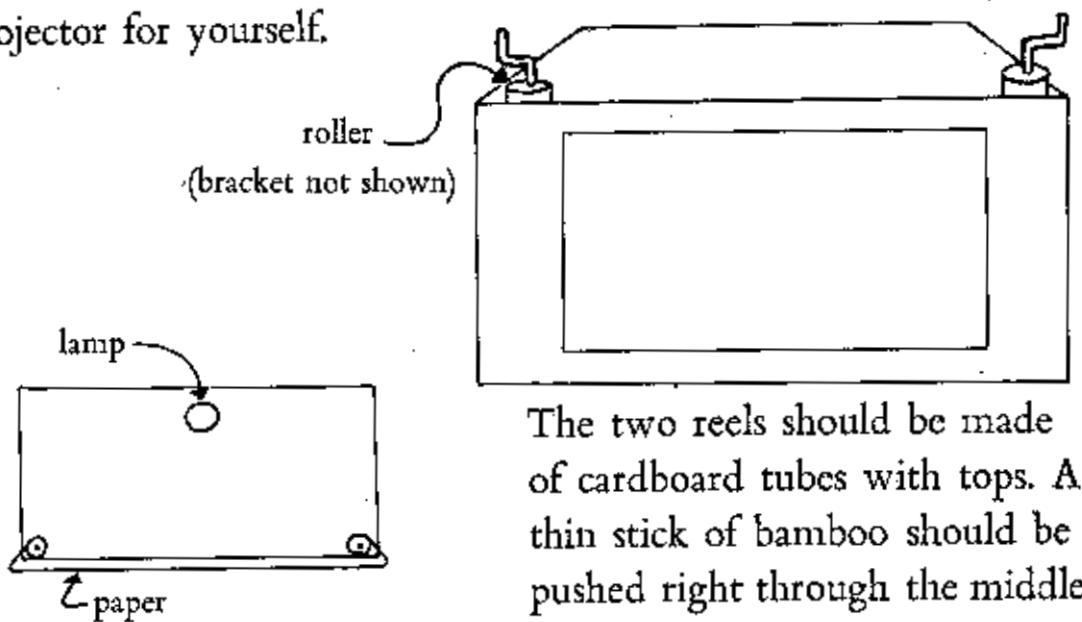
Questions : answer them in writing:

1. How does the buzzer make a buzzing sound ?
2. If A is touching G, and not touching B, what happens when you switch on the current ?
3. If B is touching A, and G is not touching A, what happens when you switch on the current ?
4. What use could you make of such a buzzer ? Draw diagrams to show how you would use the buzzer to make :
 - (a) A burglar alarm
 - (b) A device to tell you when your water-tank is full
 - (c) A timing device (could you use the idea of a sand hour-glass pressing the switch ?)

Clue to help solve 2. and 3. above : The coil only works as a magnet when the circuit between it and the battery remains unbroken. This is called a make-and-break device. Why ?

A Film Strip Projector

You may have seen a film strip projector in your school. It throws an image on to a screen just as in a cinema, but the pictures do not move. You can easily make a model film projector for yourself.



The two reels should be made of cardboard tubes with tops. A thin stick of bamboo should be pushed right through the middle.



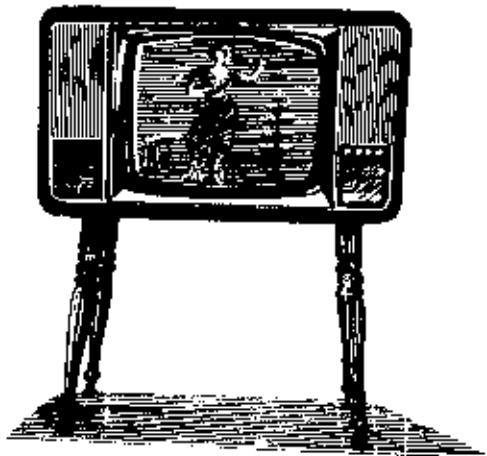
You can make brackets like the one shown

for the box,
into the holes
and the bamboo rods will go
two at each side, one at the top,
one at the bottom. Any light will do; you could use a bulb
and two batteries or an oil lamp.

Now take a long sheet of paper, say, 4 or 5 metres long, and wide enough to cover the square hole in the box. Draw a series of pictures illustrating some of your science experiments (e.g. how plants grow) or illustrating any subject of your choice.

Set up the light, wind the rollers and get your friends to see the results of your work.

Television



The word television means seeing things from a long way off (*tele*—far off and *vision*. Think of telephone, telegraph, etc.). Have you ever seen a television set? If you haven't, you can imagine what it is like from the picture above. It is like a radio set and a small cinema screen combined. It is worked by electricity: the programmes are performed in a studio in a big city, and then sent out or transmitted through the air just as ordinary radio programmes are transmitted.

In many countries in the world television is used for:

News broadcasts, information, entertainment
and education.

Television has now come to India; if you live near someone who has a television set, you may have seen one. If you were allowed to choose programmes on television for school lessons, what lessons would you like to see broadcast? Give reasons for your answers.

What do you think the various knobs at the side of the set are for?

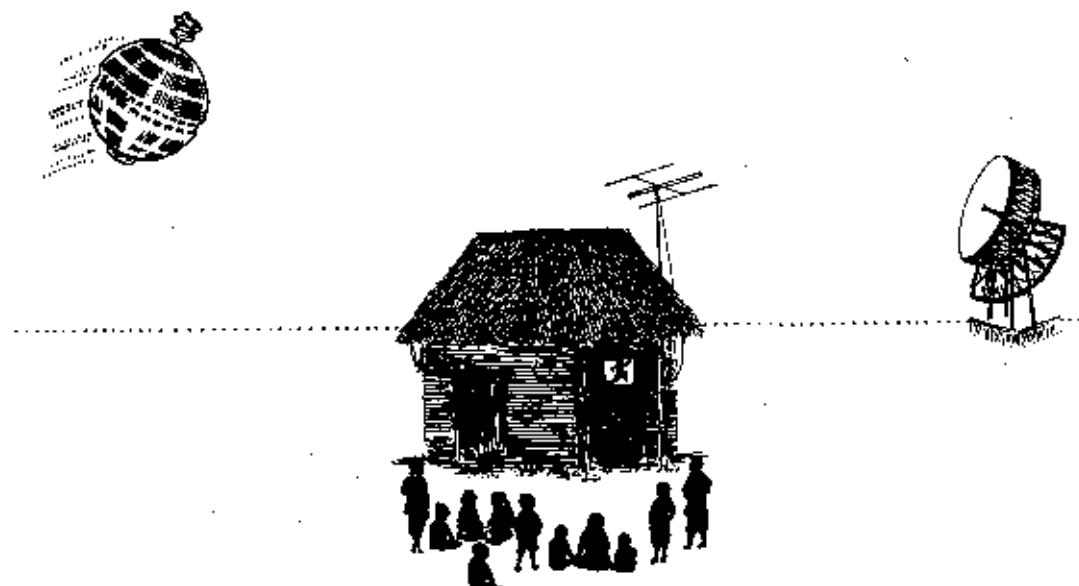
Television

One of the difficulties of transmitting television programmes is that very high-powered transmitting sets are necessary. Even then, people far away from cities, in villages, cannot easily receive the programmes.

In 1975 India received her first television programmes from a satellite. The programmes were prepared by AIR and sent to Allahabad. Allahabad transmitted them to the satellite, and the satellite sent them back to television sets in villages. Because of the satellite, remote villages in six states were able to see TV (short for television) programmes for the first time.

Try to find out the answers to these questions:

How much does a TV set cost? Where is your nearest TV set? Would the TV set make a good teacher? Can you ask it questions?



Mass Media

Media is the plural of the word medium. Medium means the way in which things are done. Mass refers to the great mass of people in the world. Mass media of communication are the ways in which information, ideas and opinions can be given to many people at the same time.

Here are some ways of communicating: could they all be mass media?

sp....ch	ge res	sy....ls	wr ing
dr.... ing	ne rs	te ne	b ks
te ph	fi....s	ra.... o	te ion
ad nts	si....s	mu.... c	

Write down two examples of messages which might be sent by each of the media listed above.

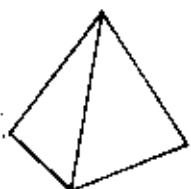
Like many scientific discoveries, none of these media are good or bad in themselves. They can be used for good or bad purposes. Unfortunately, people often believe things learnt through these media without thinking. Many people say, for example, 'It *must* be true; I read it in a book'. Remember that the authors of a book, or a film, or a programme on television, or an advertisement, may all, on occasion, give their subjective view rather than an objective view.

BE AWARE OF THE DANGERS.

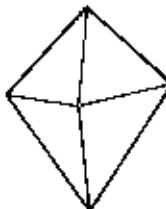
BE CRITICAL of what you hear, or read, or see. Test everything you hear or read by the methods you have learnt in your study of science. Don't take anything for granted.

Regular Solids

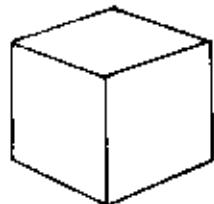
You have seen a number of solids in previous pages. There are only five regular convex solids. Here they are:



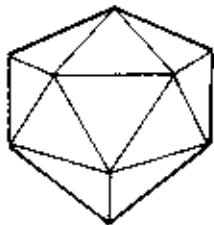
Tetrahedron



Octahedron



Hexahedron



Icosahedron



Dodecahedron

In each solid each face is the same shape and size. The number of faces is as follows:

A Tetrahedron has 4 faces.

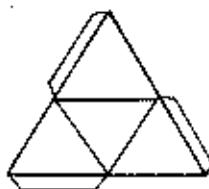
A Hexahedron has 6 faces.

An Octahedron has 8 faces.

A Dodecahedron has 12 faces.

An Icosahedron has 20 faces.

Try to make designs for making all the solids above. Here is a design for making the tetrahedron:



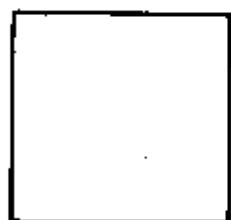
Draw designs for the others.

Regular Solids

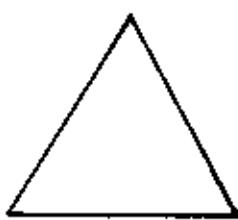
The solids on page 65 are called Platonic solids. Plato was a Greek philosopher, and in his day people thought that these five solids had magical properties.

Some of these solids occur naturally : for example, as you saw in your work on page 37, sugar crystals are in the shape of a hexahedron or cube; a diamond is in the shape of an octahedron.

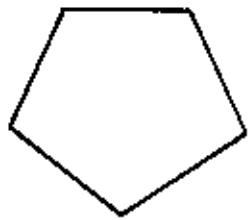
If you are going to make these solids from paper according to your designs, how will you make these flat shapes ?



a square



an equilateral triangle



a pentagon

The triangle has three sides : the angles add up to 180° .

The square has four sides : the angles add up to

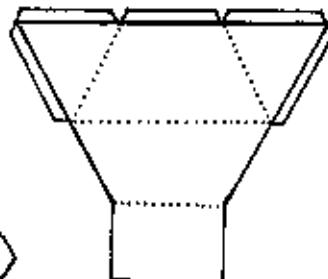
The pentagon has five sides : the angles add up to

The hexagon has six sides : the angles add up to

Continue this table with heptagon (7 sides) and octagon (8 sides).

A puzzle

Make up *two* of these figures in paper, and using them both, try to make a tetrahedron.



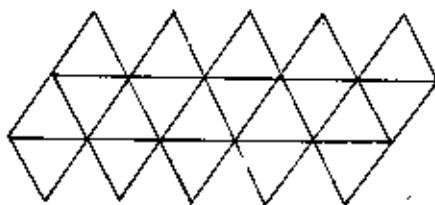
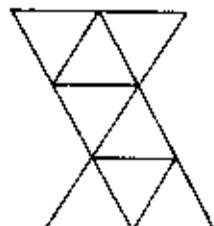
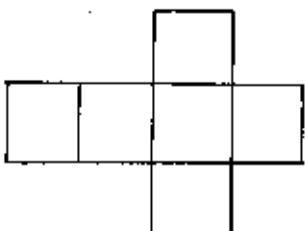
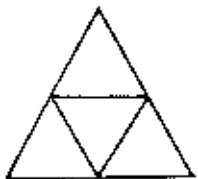
Another puzzle

What solid figure can you make with hexagons ?

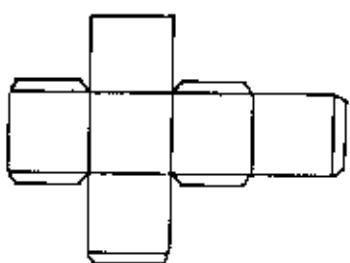


Regular Solids

Here are possible designs for making all the solids shown on page 65. Make an *alternative* design for each, using two pieces of paper, and not one as shown here :



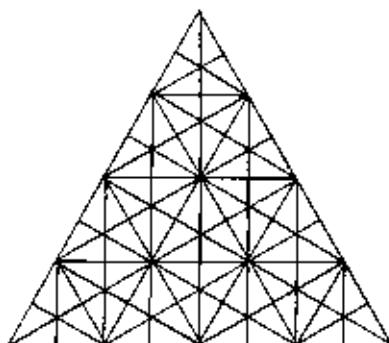
Note that in each case the tabs for sticking have not been shown. Copy all the plans into your exercise book and then put in the tabs. For example, the cube :



Put your tabs in different places.
Not as shown here. How many
different ways of putting tabs
on a cube are there ?

A puzzle

How many triangles
can you count in this
figure ?



Alternative Technology

Alternative means another way of doing things: technology means the use of science in making things. Many scientists nowadays are thinking about ways of helping people to live better by using science to invent things which will do everyday jobs more easily and cheaply. Some of these things are:

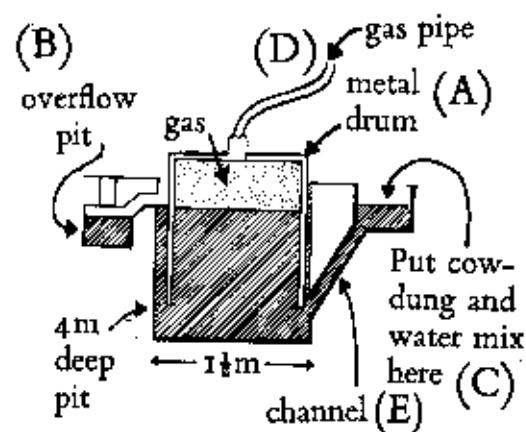
Gobar gas plants: for making cooking gas out of cow-dung

Solar water heaters: for using the rays of the sun to heat water

Windmills: for producing power to pump water and make electricity

The Gobar Gas Plant

The gas plant consists of a large metal drum (A) and a deep pit, about 4 metres deep. The cow-dung is mixed with water and poured into the small pit (C). It flows down the channel (E) into the bottom of the deep pit. After about 20 days gas begins to form on top of the cow-dung and water mixture. The gas collects in the metal drum (A) and the drum slowly rises as it fills with gas. When it is full of gas, the gas pipe (D), which is connected to a burner in the kitchen, is opened. The gas is lit and the burning gas cooks the food. Cow-dung and water is put into the pit (C) every day: as it goes down to the bottom of the deep pit it pushes out some of the old mixture into the overflow pit (B): it is removed from this pit every day. The mixture from pit (B) (cow-dung from which gas has been removed) is *better* as a fertilizer than ordinary cow-dung.



Alternative Technology

On page 68 you learnt about Gobar Gas plants. Here is a picture of **A Solar Water Heater**

The solar water heater has a water tank (D) which can hold 70 litres of water. The collector (A) is made of two sheets of metal joined together with bolts, with a space between (about 5 mm) for the water. Above this is placed a glass sheet. The top sheet of metal is painted black. The water flows down

pipe (C) into the collector (A). Because there is a very *thin* layer (5 mm) of water, the sun, when it shines on the black metal, heats this layer of water very quickly. Hot water rises, just like hot air, and when the water is heated it rises up the pipe (B) and into the top of the tank (D); then more cold water flows down (C) into the collector. In this way all the water in the tank gets hot.

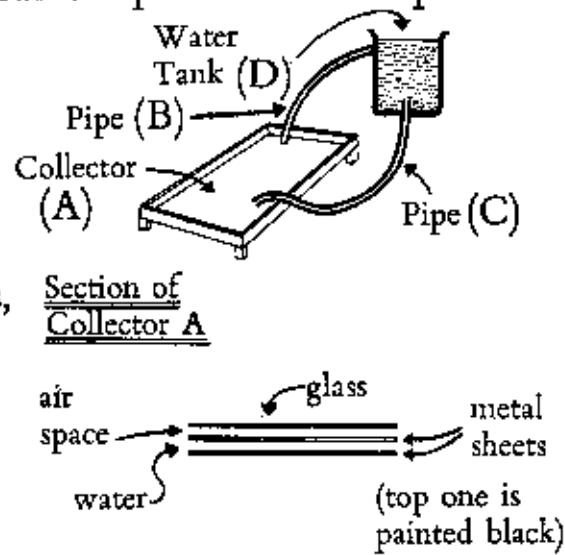
Windmills

You have read about windmills in previous books. How do you think scientists could improve windmills? Draw your own idea of a windmill. Would it go better with 3 sails, or 20 sails? What else could a windmill do as well as pumping water? Think of some useful machines which could be worked by windmills.

In the drawings on page 68 and on this page, of the Gas Plant and the Solar Heater, some important things have been left out. What do you think they are?

Two questions:

1. How could you keep the metal drum (A) from falling over to one side?
2. How could you keep the water in tank (D) hot for a long time? Write more questions of your own.



Hypotheses

A hypothesis means an explanation of certain facts which needs to be tested by experiment in order to find out if it is true. The plural of *hypothesis* is *hypotheses*.

For example, you might find that the buzzer which you made (pp. 58–60) does not work.

A hypothesis could be: it doesn't work because the batteries are too weak.

How would you verify* this hypothesis by experiment?

Variables

Variable means that which can be changed. In any experiment, many of the things used, or the methods used, can be changed; these are known as *variables*. For example, we might make the following hypothesis:

Thick string breaks more easily than thin string.

You could test this hypothesis by getting a number of pieces of string of different thicknesses and tying weights on each string until it breaks.

Variables might be: What is the string made of?

You can see how important these variables are in testing your hypothesis.

(Perhaps nylon string is stronger than cotton; perhaps cotton is weaker than coconut fibre.)
Is the string old or new?
Is all the string made in the same way?

Think of variables in the following hypotheses:

- Things float more easily in salt water.
- Hot liquids keep hotter in black containers.

* Verify means 'to make sure something is true'.

A Systematic Approach

An *approach* means moving towards something. When we are going to look at a new problem we say we are going to approach the problem. *Systematic* means arranged according to a plan. For example, the buzzer you made has again failed to work. A systematic approach to the problem is required. This means listing all the ways in which the buzzer could have failed. Write a list of things which could go wrong with the buzzer, like this:

1. Batteries worn out.
2. Wires broken.
3. Connections ...

(Continue the list: make it as long as you can.)

When you have listed all the possibilities, you use a *systematic approach* by testing each one in turn.

Let's take another problem:

How does light help beans to grow?

What are the variables? There are lots of them.

- (a) The direction of the source of light.
- (b) The strength of the light.
- (c) The soil.
- (d) Are all the seeds the same?
- (e) The container, and so on.

If we are interested in *light*, we must try to see that all the variables are *controlled*. For example, we can see that for all the beans we grow the light comes from all directions. How could we control (b) (c) (d) and (e)?

Draw a picture of the experiment with beans in your books.

Control all variables. Then you can try changing the one variable (light) in which you are interested, e.g. a little light, a lot of light, no light at all.

Classification

(Before you read this and the next page, read again pages 34 and 35.)

Classification means putting things in classes, just as teachers classify children and put them into Standards. For example, we can classify names of children by putting them in alphabetical order : all the names beginning with C go in one group, all the names with D in another, and so on. Try to classify all the children of your class in 3 ways :

- (1) Those who have only brothers, those who have only sisters, those who have no brothers or sisters, those . . . (four classes : what is the fourth one ?)
- (2) Those who like mathematics and those who don't. (How will you find out ?)
- (3) Those who are good at maths and those who are not. (How will you find out ? Will the lists in (2) and (3) be the same ?)

Classification of Animals

Animals are usually classified into two groups :

Vertebrates and **Invertebrates**

(having backbones) (having no backbones)

Mammals	Molluscs	Note
Birds	Arthropods	These are only
Reptiles	Worms	some of the
Amphibians	Sponges	invertebrates.
Fishes	Protozoa	

Mammals : warm-blooded animals which give milk to their young.

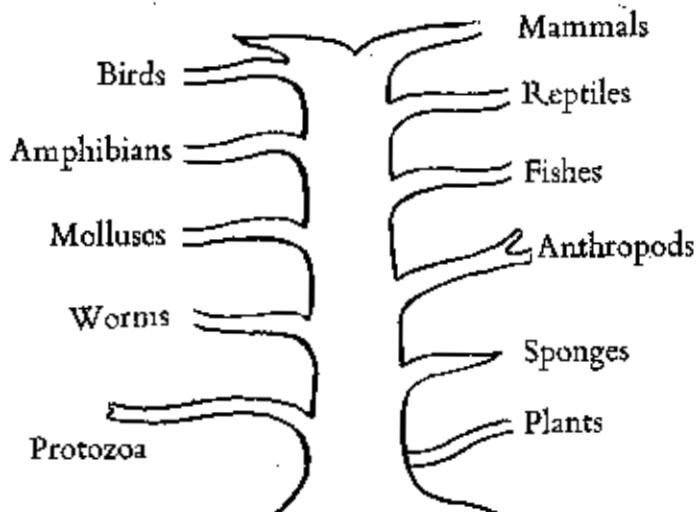
Amphibians : creatures such as frogs who live both on land and in water.

Molluscs : creatures with shells. *Arthropods* : creatures with jointed legs, such as insects, spiders and scorpions. *Sponges* : attach themselves to rocks in pools of water. *Protozoa* : the tiniest animals, invisible to the naked eye.

Animal Classification

If you look at the lists on page 72, you will see that the animals are roughly in order of size. (What exceptions* can you see? Write down the exceptions in your books.)

The animals in the lists can conveniently be shown on a tree, like the one below. We might call it the tree of life.



Now, as you know, there are many kinds of birds, many kinds of insects, many kinds of mammals. You can imagine each one of these main branches having lots of smaller branches, then twigs, then leaves. Arthropods, for example, include Insects (a smaller branch of Arthropods): Insects include Ants and Butterflies (smaller branches): there are many different kinds of ants: and so on.

Draw a *very* large tree with the help of your friends, and find or draw pictures of some of the creatures and stick them on to the tree in the correct places.

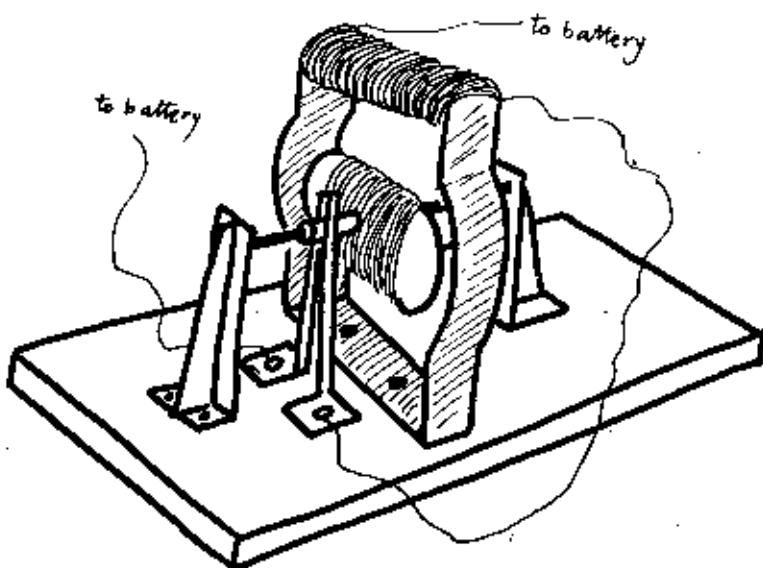
Where would man go on the tree?

* *Exception* means 'something not covered by a rule'.

An Electric Motor

For this model you will need some tin, some thick cardboard, a piece of wood about 12 cm \times 18 cm, 2 cm thick, some nails, some screws and some cotton or plastic-covered wire.

First, look carefully at the drawing of the finished motor below and try to see how the parts are put together.



Now look at the drawings on page 77. The motor consists of a base of wood A, the wheel magnets B, the armature C, the brushes D and the armature supports.

First make the wheel magnet B. A full scale side-view is given on page 77. Make it out of a strip of thin metal of 4 or 5 thicknesses of tin, welded into one piece; the finished strip should be about $2\frac{1}{2}$ cm wide. Shape it to the pattern shown and

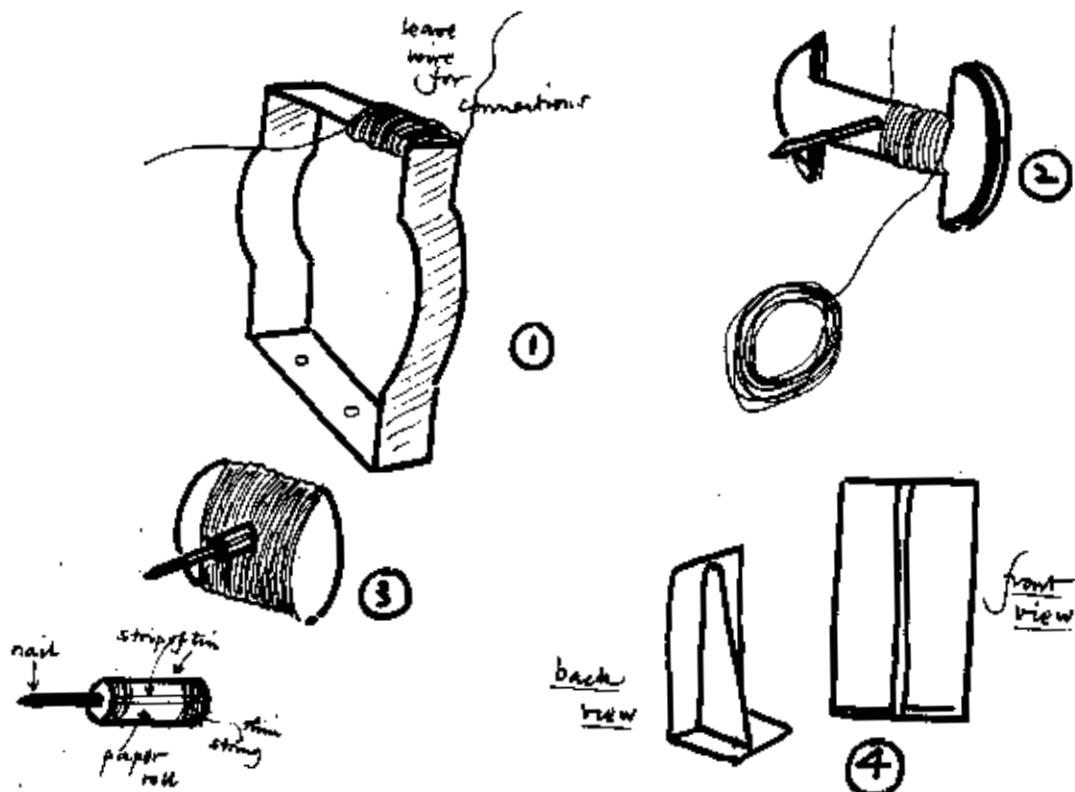
An Electric Motor

bore two holes where the bottom pieces overlap so that it can be fixed to the base. Now wind wire (about 8 metres) round the top of B (see Figure 1, page 76). Leave about 8 cm of wire at each end for making the connections.

The armature A is made of six pieces of tin. Trace the design of A (page 77). Make a paper pattern and cut out six pieces of tin. Hold them together and punch a hole through the centre. Through this hole put a 6 cm nail so that it is a tight fit. Now wind wire; start at centre (see Figure 2, page 76), winding in a clockwise direction. Then wind back to the centre. The wire should come level with the point X. Then wind on the same number of turns on the other side of the wire. Make sure that you continue to wind the wire in the clockwise direction. The commutator (see Figure 3, page 76) is made by winding tape or sticking paper over the nail till you have made a roll about 1 cm thick. On the top and bottom of this roll lay two thin strips of tin about 2 cm long and 3 mm wide. Bare the end of the wires which come from the armature and put one wire securely round each piece of tin. Bind the ends tightly with cotton thread. Now make the armature supports; you will find patterns at C on page 77. Cut them out of thick cardboard and make up as shown. Make a hole in each part labelled C₁ in the place shown. Now take a small piece of tin (C₄) and weld it over C₁ along the dotted lines, so that the central C₄ is over the hole in C₁. Turn the edges back and hammer them tightly. Now take a nail and make a dent in

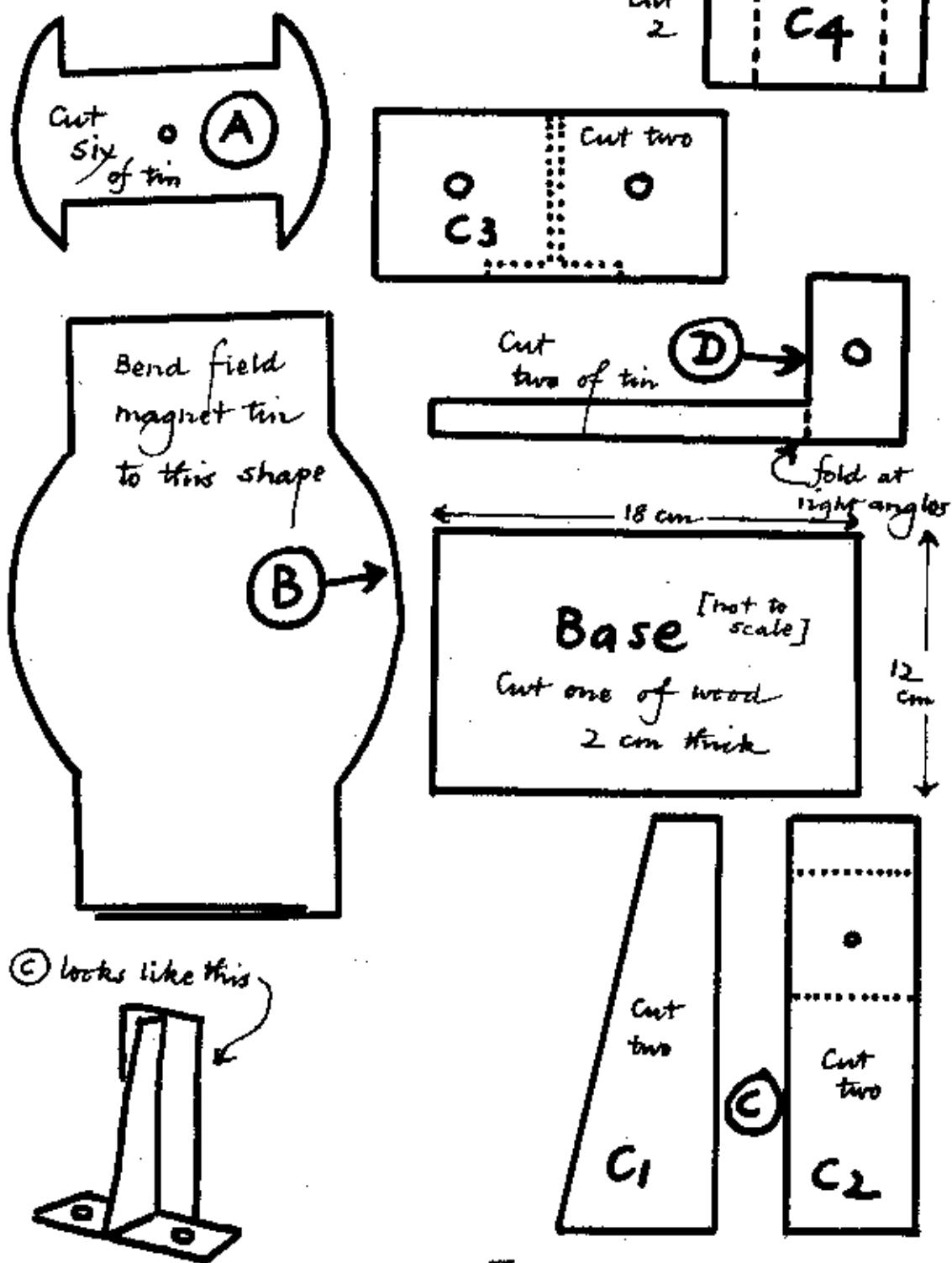
An Electric Motor

the tin just over the hole in C1. *Don't* go through; the nail of the armature will rest in these dents. Remember that you want two sets of C to support the armature. Cut the brushes out of tin as shown at D on page 77; two are required.



Now you can put the motor together. Screw the parts through the base board as shown on page 74. Make sure the nail is pointed at both ends and raise smoothly on the dents. Then wire up as shown and connect to the batteries. Bend the tin brushes so that they just bear against the commutator; they should not stop it going round freely. Give the armature a spin and your motor will go.

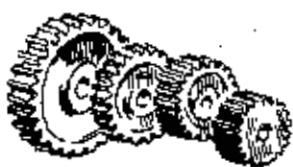
An Electric Motor



Gears

(Read again pages 32-33.)

You may remember that one of the ways of changing direction was by using gears. Here are some more ways in which gears can be used:



Cylindrical Gears



Mitre Gears



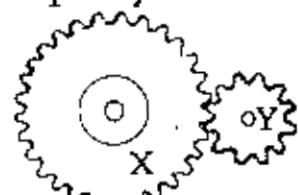
Worm Gear



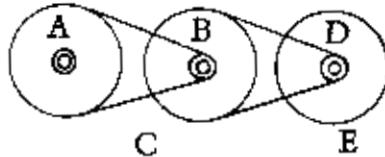
Internal Gear.

Gears and pulleys can also change speed, as well as direction :

(1)



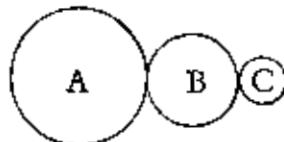
(2)



In (1), if X goes clockwise, which way round will Y go?

In (2), if A goes clockwise, which way round will D go?

Gear differences are often shown as a ratio. For example, if X is 15 cm in diameter and Y is 1 cm in diameter we say the gear ratio is 15 : 1. What do you think the ratio is between A and C below ?

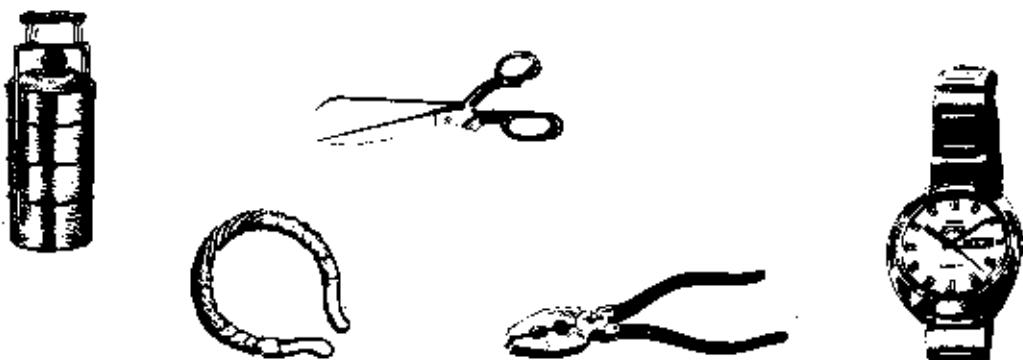


A is 15 cm B 10 cm C 5 cm
diam diam diam

Find some gears like the ones shown above : try to see how they work ; try to work out the ratio. Some suggestions—lathes in mechanic's workshops, cycles, old cars, clocks and watches, printing works, sugarcane crushers, farm machinery.

Plating

Plating means putting a thin coat of metal on something.
All the articles in the picture below have been plated:



Here are some forms of plating in common use.

Chromium plating—cycle parts

Gold plating—necklaces

Copper plating—welding rods

Zinc plating—roofing sheets

Brass plating—lamps

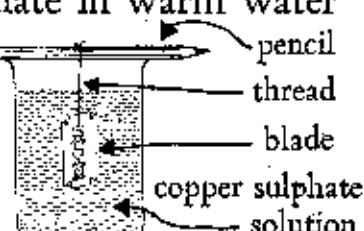
Tin plating—food tins

Silver plating—ear-rings

One example of each has been given; see how many more you can write under each heading.

Plating a blade

You can do some copper-plating at home. Go to the chemist's shop and buy a few grammes of copper sulphate. Be careful—don't eat it—it is poison. Put the copper sulphate in warm water and stir it until it dissolves. Then tie a thin piece of thread to the blade, and hang it on a pencil. Suspend the blade in the solution. Watch carefully. Write down what you see.



Mould

Mould is a kind of Fungus (plural *Fungi*, pronounced fung-eye). Read page 11 again. Do you remember your drawing of a mushroom?

You will find mould on food which has gone bad. Moulds do great damage to food by causing it to be wasted; they also do great good by helping vegetable matter to rot and turn into compost.

We can find mould on bad food and also in the form of mildew, which forms on leather articles in the rainy weather. Sometimes a disease is caused by a fungus—ringworm, for example. Penicillium, which as you know is used in drugs, is a mould.

If you can get a magnifying glass you can examine some mould.



bread



guava



cheese

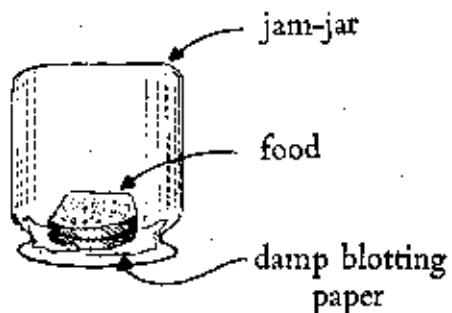
Perhaps you can find bread, or fruit, or cheese which has gone bad.

The mould does not produce flowers or seeds. It produces fruiting bodies, and these in turn produce spores. Some of these spores float in the air, or on water.

Growing Moulds

Try to grow moulds as follows :

Take some bread, or cheese, or fruit : preferably a selection. Put them on damp blotting paper and cover them with jam-jars.



If you can co-operate with your friends, you can grow a large collection of different moulds.

You can use the following :

Bread, chapati, cheese, curds.

Fruit of various kinds, vegetables.

Dead flies in dirty water.

Try to discover the answers to these questions by experiment :

Do moulds grow better in the dark or in the light ?

Do they grow better in a warm place or a cold place ?

Do they grow with air or without air ?

Do they grow in a solution of sugar and water ?

What generalizations can you make about moulds from your experiments ? Can you form any general rules for keeping food free from moulds from these generalizations ? Do foodstuffs in your house ever go mouldy ? Why ? Can you prevent this happening ?

Designing Machines

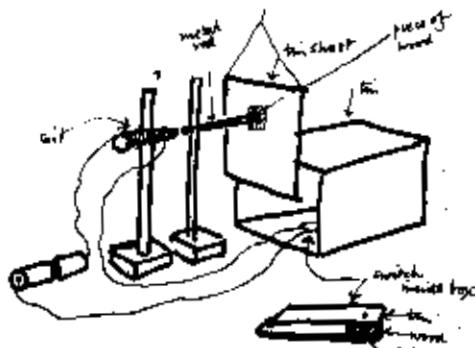
Have you ever tried to design a new machine? Remember that a machine should help you to do something more quickly, more easily, and perhaps better, than by hand.

You need to think about a great number of things when you are designing machines:

The source of power : the object of the machine : the way in which the power will work : the details of construction.

You will need paper and pencil—think with a pencil in your hand. Try this idea :

A rat-trap worked by electricity



Note that the picture gives you ideas only. You will have to work out the details of how it is to be made. How big will the box for the trap be? How will the door fall? How will you make the door heavy enough? If the coil is *on*, and the door falls, the coil will remain on: can you think of a way of cutting off the current from the coil? (or else your batteries will run down). Perhaps you could use the 'falling power' of the door. How?

Draw. Write descriptions.

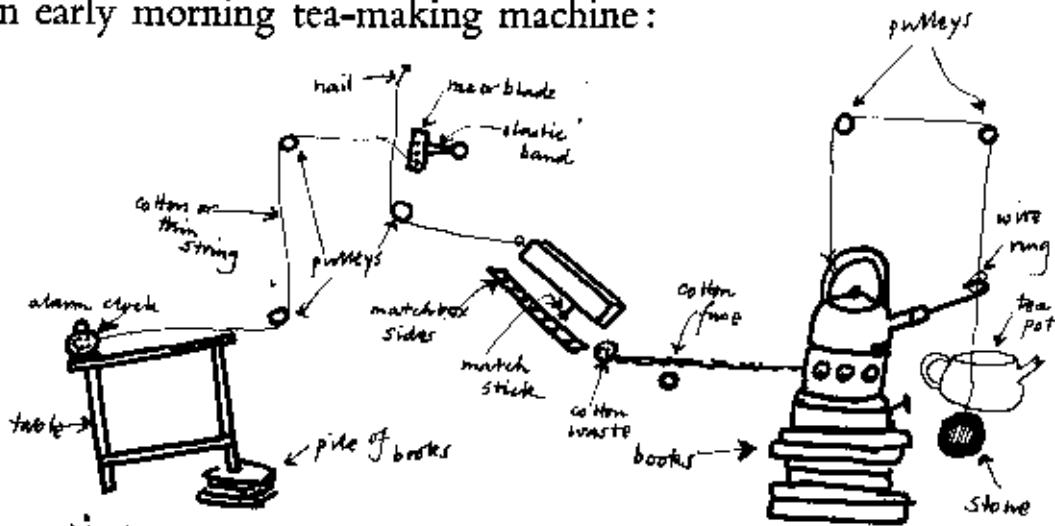
Then show your work to your friends and to your teacher.

Perhaps they will find some faults in your design.

Try to change it after listening to their comments.

Designing Machines

An early morning tea-making machine:



Questions

How is it supposed to work? Will it work? What might prevent it from working? What is the source of power? What happens when an alarm clock goes off? How could you make a fuse? How does the kettle tip up and pour boiling water into the teapot? What difficulties would you find in making it? Write them down. Can you make it? Get your friends to help you.

More Designs

Try to make designs for machines of your own. Use your ideas, or try these:

A machine for shelling groundnuts. A fly-trap.

A burglar alarm. A wind-powered lorry. A machine for making pots on a potter's wheel. A seed-sowing machine to be drawn by bullocks.

Draw And Write Descriptions

Learning

Can you spin a top?
Do you remember how you learnt? Spinning a top is a skill, and if you can list the steps in learning how to spin a top, you can learn other skills. Perhaps you learnt something like this:



- i Observing your friend spinning his top.
- ii Wanting to spin your own top.
- iii Trying to spin it, and failing.
- iv Observing your friend again.
- v Practising until you got it right.

This is the way we learn new *skills*. A skill is something we *do*: some of the skills you have learnt are:

reading, writing, drawing, observing, asking questions.
See if you can think of any more skills you have learnt.

Remembering

Read each of these poems three times and see if you can say them without looking at the book:

(A)*

Wele goelcerth wen yn fflic
A thafodau tan yn bloeddic

(B)

Over the mountains
And over the waves
Under the fountains
And under the graves.

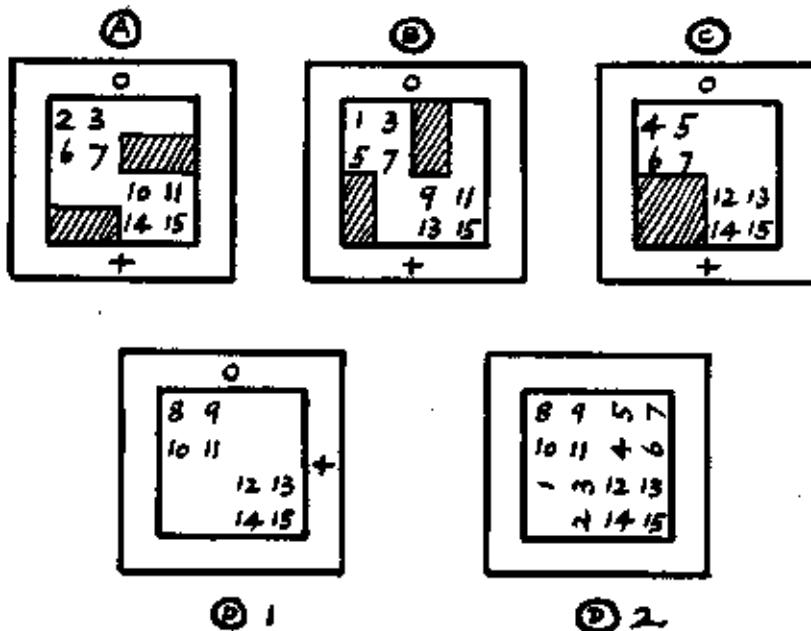
Which was easier to remember, (A) or (B)?

This shows another very important factor in learning: if you want to remember something, understand it first. Then it will be easier to remember.

* (A) is in Welsh.

A Trick with Numbers

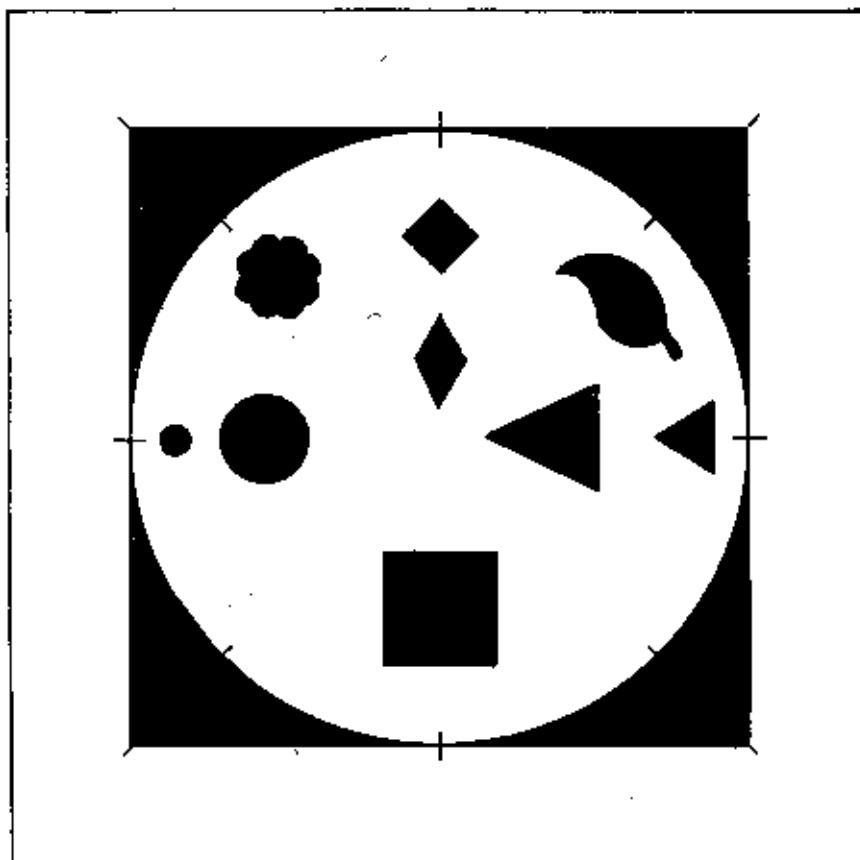
Paste the diagrams below on to cardboard and cut them out. Use a razor blade and cut away the spaces marked with diagonal lines. Note that D₂ is to be stuck on the back of D₁. This is very important. You will now have 4 cards —A— numbers on front, blank at back; B—numbers on front, blank at back; C—numbers on front, blank at back; D— numbers on front and at the back.



Ask someone to think of a number from 1 to 15. Show her a card A. If her number is on it put it down with o at the top; if her number is not on it put it down with + on top. Do the same with D and C and put them down on top of A. Then show her D₁: Put o or + at the top (as in A B C): put on top of other three cards: turn over the four cards and the number she has chosen will show through the spaces in the cards.

A Pattern Maker

Trace the design below on two pieces of cardboard, the thicker the better, and cut out the two pieces. Note that the shaded portions are to be removed; you will need a razor blade for this.



In order to use a pattern maker place the circle inside the square, choose one of the cutouts and trace it on to paper. Then move the circle round a quarter turn and trace the same pattern. In this way you can make a great variety of patterns by using the shapes and perhaps putting one on top of the other and shading them in different colours.